J. Nelson Spaeth.

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JOURNAL OF FORESTRY

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EDITORIAL

The Foundations of Professional Ethics

IN the closing days of 1910 a conference on forestry education was held in Washington. Among those in attendance was the President of Lehigh University. As the conference closed he spoke with manifest earnestness of something with which the two-day session had deeply impressed him. No profession, he was convinced, could compare with that of forestry in whole-hearted devotion to the purpose of public service.

In 1910 nearly all the professionally trained and professionally active foresters in the United States were in federal or state employ or in teaching positions. Men engaged in public or quasi-public work would naturally measure up to high standards in devotion to their common profession and recognition of it as a public cause. A still more potent influence was the purpose, single-hearted zeal, and fighting temper which Pinchot as the accepted leader of the whole forestry movement kindled in his followers, and especially in the ranks of the Forest Service.

Now, almost a generation later, age and change combine to cool that youthful ardor, so that forestry is much less obviously a public cause and more extensively a means of livelihood. The members of the Society of American Foresters are numbered by the thousands, and there are other thousands of graduated foresters who are nonmembers. Neither in cohesiveness nor in unity of purpose can the profession be expected to be what it was in its years of beginnings in this country. Yet the sense of peculiar public obligations is fundamental, for any profession.

It is more fundamental than the requirement of a specific educational prerequisite. It becomes the underpinning of the structure that discriminating judgment must rear as problems of ethical conduct arise. For obviously, no body of men within the state can justify as right a course of conduct advantageous to their own group but disadvantageous to the public; antisocial conduct is *ipso facto* unethical. Either there is no special field of professional ethics or it is a field created by special social obligations arising from a unique functional service.

A good example is found in the field of journalism. That journalism deserves to be ranked as a real profession, despite the fact that to get on a newspaper one does not have to master a body of specialized knowledge and take a corresponding degree or examination, is best seen from its well developed code of ethics. The code is unwritten, and there is no centralized machinery for enforcing it; but it is obeyed. Its cornerstone is the quasi-public function of the press and the

special obligations that this imposes upon reporter, editor, editorial writer, and publisher.

The "Principles of Medical Ethics" of the American Medical Association stem from their opening declaration. "A profession has for its prime object the service it can render to humanity." Whoever chooses the profession of medicine "assumes an obligation to conduct himself in accord with its ideals." If one agrees with this, the claim of forestry to be rated a profession falls unless a purpose of public service governs; and professional conduct must accord with that purpose.

The purpose of public service to which American foresters as a professional body owe allegiance is the purpose to apply our specialized knowledge toward making the country's forests yield their fullest contribution to the economic and social welfare of the Nation. On that foundation only, in addition to the broad general principles that underlie all moral conduct, can we build up a sound professional code of ethics.

Whether foresters need such a code has been a question much longer than is commonly realized. As early as 1914 Professor Fernow touched on it in an address before the Society. The following year he dealt with it more fully. Because of the youth and small size of the profession in the New World up to that time, such cases as had arisen could be settled without apparent need to consult associated opinion. But growth and more complicated relationships would call for greater watchfulness, make application of the principles of equitable conduct more difficult, and necessitate "a certain solidarity of interest" in applying them. Fernow believed that "the *esprit de corps* which keeps men on a high plane of moral conduct is unusually well developed among foresters generally"; and he held it axiomatic that the general principles which should guide conduct are to be sought in the golden rule and the decalogue. But in given cases conflicts of principle arise, where "most delicate judgment is required . . . . and there are cases on which authorities of high standing will differ."

"I would not advocate, as has been done in other societies, the formulation of a rigid and binding code of professional ethics which the Society would enforce. The fact that so many cases arise which cannot be brought under strict rule, but require delicate judgment on the basis of specific conditions, militates against such a proposition." "I would make the Society a forum before which such questions of ethics may from time to time be brought and discussed." And "I would go one step farther, and suggest a standing honor committee, whose business it should be to bring such matters to discussion; and, more than that, a committee to whom members may refer delicate problems for expression of opinion and advice." In time, as concrete decisions built up an adequate basis, "at least a suggestive code might be the result."

Other foresters followed Fernow in bringing the same subject before the Society. F. E. Olmsted went farthest in raising questions as to the professional obligations of foresters with respect to their form of employment. At the 1921 Annual Meeting he read a paper entitled "Professional Ethics", which began: "When is a forester not a forester?" If engaged in lines of work—timber brokerage, lumbering by companies unconcerned for forest perpetuation, the service of a forest exploiting association, even fire protection not integrated with definite silvicultural purposes—has he not abandoned forestry, in practice and in spirit? These questions were merely raised, not answered; but he concluded:

"Finally, is there or is there not a relation between the professional standing of a forester and his regard or disregard for the public welfare in his work? The loyalty of a forester in private employ to

his employer is a most laudable thing. Equally praiseworthy . . . is a reasonable concern for the public good, and I do not see that these two things need necessarily conflict. Does regard for the interrelation of private and public forest interests place professional ethics upon too high a plane? Let us remember that the practice of forestry must be brought about by foresters, and that the success we obtain will depend to a marked degree upon the professional standards we uphold."

The concern of the legal profession is service of the common welfare in the dispensation of justice; of the medical profession, service of the common welfare in the maintenance of physical and mental health. On these purposes are founded their respective codes of professional ethics. Should not foresters recognize as basic for their profession a like service in the field of their specialized knowledge? Amongst the many callings that are now claiming professional rank, too often the primary aim in establishing rules of practice seems to be self-interest; the safeguarding of a particular field of gainful activity against invasion from outside, the limitation of competition for business in order to maintain standards of compensation, the promotion of solidarity and the upbuilding of prestige and favorable opinion for the sake of group benefits. And the organization of purely business interests has added to "professional ethics" so-called "trade ethics" until the term has come to be in some disrepute as a camouflage for practices to bolster monopoly. This is not to say that a profession should abstain from concerning itself with such matters as proper standards of qualification for those aspiring to practice it, or proper observance of rules of honor and fair play within the profession, or conduct which tends to lower the profession in public esteem. But the first matter of solicitude should be not what will be most beneficial to the profession, but what will make the services of the profession most beneficial to the public.

Society opinion on the desirability of a formal code for foresters is probably still uncrystallized. There is suggestiveness even now in some of the thoughts propounded by Professor Fernow more than twenty years ago. He believed that the Society should concern itself with the establishment of ethical standards, but that these should be gradually built up on a basis of actual cases and decisions, not devised as a more or less theoretical framework. He recognized that decisions would often be difficult, that fixed rules could not be automatically applied, and that particular situations would have to be dealt with individually and discriminatingly. He therefore held that the task of making decisions ought to be given initially to a small group of men in whose experience and keen sense of what is right and honorable the Society could most safely trust, and that in judging conduct the question should not be whether it conforms to special rules for the profession, but whether it conforms with the fundamental principles of integrity, fairness, and honorable relationships that are generally applicable in human relations. The heart of the matter is ideals—the ideals of moral behavior that lie back of social obligations in all fields of our complex national life, and the ideals of service that spring from the very nature of the profession of forestry. Objectives of the profession and the ethics of the profession may not be dissociated.

HERBERT SMITH—AN APPRECIATION

THE retiring Editor, Herbert A. Smith, has given two years of devoted service to the Society as Editor of the JOURNAL OF FORESTRY. His retirement was necessitated by obligations to the Forest Service for the completion of a project dealing with the history of forestry in the United States, for which an extension of his appointment in that organization for one year beyond the age of retirement was personally granted by President Roosevelt.

In his editorials, Mr. Smith has drawn on his wealth of historical information covering the entire history of the forestry movement in the United States. He has been with the Forest Service since its origin. He has also followed intimately the development of state forestry, and prepared the chapter on that subject issued as part of the extensive Copeland Report in 1933.

Mr. Smith was chosen to carry on the traditions attached to the editorial position, of comprehensive knowledge of the general field of forestry, intellectual integrity, independence of opinion, sound judgment as to issues, and an ability to present subjects fairly, in the effort to promote better understanding of controversial questions and aid the Society in their solution for the general benefit of the public and the profession. In all these qualities he has demonstrated his ability, and it is with deep appreciation and regret that the Council reluctantly acquiesced in his retirement.

Mr. Smith's contribution to the success of the JOURNAL has by no means been confined to his editorials. He has conscientiously edited all articles submitted for publication, read proof of all copy, and in many other ways given liberally of his time and strength to raise the standard of the JOURNAL to a professional level creditable to the Society. He also had definite plans for the improvement of the set-up and appearance of the magazine, which are now postponed for the consideration of the new editor.

It has been the Society's good fortune to have secured even for this brief period an editor-in-chief so widely known and respected and so unselfish in his devotion to his duties. We are sure that the members of the Society join with the Council in wishing him a long and enjoyable period of future activity professionally and otherwise.

H. H. CHAPMAN, *President*,
FOR THE COUNCIL.

SCARIFICATION AND GERMINATION OF BLACK LOCUST SEEDS

By J. K. WILSON

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THE demand for plants adapted for erosion control has increased enormously in the past few years. Black locust (*Robinia pseudoacacia*) has been highly recommended for this purpose. To meet this demand nurseries have been established to grow seedlings. Seeds from native trees have been supplemented by large importations. The immediate germination of these seeds is seldom more than 10 per cent and in many instances less than 5 per cent. A hard seed coat that prevents the imbibition of water is largely responsible. Once the seed is properly scarified, moisture is readily imbibed and germination begins.

A method of scarification that will not injure the seed and that will permit moisture to penetrate readily to the embryo of every seed is highly desirable. Several methods have been proposed for this purpose. A worker employing a particular method may have fair success with it, while another worker may fail and find a different method more useful. These irregularities have resulted in confusion. Information that will help to clarify this situation should be welcome. It is believed that this study of the variability of black locust seed from different localities to germinate when scarified by the commonly recommended methods may have a bearing on this problem.

Source of Seeds

Seeds for this study matured in 1934. The pods were gathered from small and large trees and the seeds were threshed out after the pods were held for a day or two in sacks. The seeds were stored in glass jars, the covers of which were screwed down snugly on rubber circles. Several collections were made. Two, which exhibited extreme differences in physical appearance, were selected for this study. One is described as of a mottled gray color. Some of these gray seeds were weighed and the number in a pound was calculated. It was found to be about 30,000. The content of moisture in these seeds was 4.8 per cent. The other sample was harvested from trees in a nearby locality. These seeds were ebony; no gray was evident. They were much larger than the gray seeds. The number in a pound was calculated from weighings to be 17,500, and the moisture content was 4.6 per cent. A third sample was from California. It was found to contain about 21,000 seeds in a pound. The content of moisture in these seeds was not determined. Burton (1) points out that seeds from different localities vary widely in the number in a pound.

Treatment of Seed

No uniform recommendations for the treatment of locust seeds to increase germination have been promulgated. It is doubtful whether recommendations can ever be uniform. The number of hard seeds and the degree of hardness in any sample as well as the moisture content may vary with several conditions. These conditions will influence the severity of the treatment that the seeds should receive. One species of legumes, such as alfalfa (*Medicago*), may have 2 per cent of hard seed in one sample and 40 per cent or more in another. Also, seeds of red clover (*Trifolium repens*) or of Vetch (*Vicia villosa*) may show a similar variation. It might be suspected, therefore, that the seeds of black locust would be no exception. The degree of hardness of these seeds is greater than that of

many legume seeds, and this is probably the main reason for delayed germination. The severity of the treatment such legume seeds should receive to induce a maximum germination would undoubtedly vary from year to year, depending on the source of seed and their content of moisture.

A variety of treatments have been suggested for stimulating and increasing germination of the hard seeds of legumes. After a preliminary test, only two seemed to give promise with black locust seeds. These were the sulphuric acid and the hot water treatments. Both have been recommended freely for black locust seeds. Tillotson (5) suggested soaking the seed in water nearly to the boiling point and, after they have swollen, planting them at once, repeating the soaking for all seeds that did not swell the first time. This method may be employed for small quantities of seed, but the separation of swollen seeds from the others is a tedious task. Tillotson gives no definite recommendation for this procedure. The ratio of seed to quantity of hot water will probably determine the beneficial effect of the treatment on the seeds. Other workers have used this method with varying degrees of success (Durland and Toumey, 2).

Sulphuric acid for scarifying legume seed has been employed for some time. Love and Leighty (3) used it on clover seed, and its use on black locust seed is a common recommendation. It was employed by Burton (1) in a study of the variation in characteristics of black locust seeds from Idaho and from Austria. He treated the seeds for 30 minutes in the concentrated acid. Meginnis (4) recommends the soaking of the seeds usually for 45 minutes to one hour.

In the present tests with hot water, the seed were either steeped by covering with various quantities of boiling water or boiled in water for various periods of time. The seeds for treatment in hot water at a temperature below the boiling point were placed in thin-walled beakers, and the latter placed in a boiling-water bath just before the hot water was poured over the seeds. The temperature of the water when it flowed over the seeds was near 97°C. The beakers were then removed from the bath and kept on the laboratory table. The seeds remained in the hot water until the temperature reached that of the surroundings. After draining off the water, the seeds were placed between moistened filter paper in large petri dishes and held at 23°C. for a test of germination.

In order to treat the seeds by immersing them in boiling water, they were placed on small squares of cheesecloth. The corners of the squares were drawn up and held by a rubber band. These bunches were dropped into the boiling water and kept there for definite periods of time. The water was kept in a state of ebullition during the treatment. Afterwards, their strength to germinate was tested.

The following method was used to scarify the seeds with concentrated sulphuric acid. One cubic centimeter of the acid was added to 100 locust seeds in a tumbler. In preliminary tests this quantity seemed to be as effective as a larger quantity. The tumbler was covered with a watch glass to reduce the absorption of moisture from the air. After remaining in the acid for varying periods of time the seeds were washed in water and then immersed for a few moments in a strong filtered solution (about 2 per cent free chlorine) of chloride of lime. This was advisable after treatments of long duration, for the seed coats seemed to absorb the acid so firmly that it did not come off readily in water. Thus it interfered with germination. After this treatment also, the seeds were placed between moist filter paper in a large petri dish. Each day the treated seeds were examined, and

those that had sent out a radicle were removed and counted.

Presentation of Data

The data obtained from treating the seeds of black locust in various quantities of boiling water are shown in Table 1. The quantity added ranged from 10 to 500 c.c. for each lot of 100 seeds. This is about 7 to 350 times the volume of the seed. Although the larger quantities are hardly practical, they do show the effect of the volume of hot water as a scarificator. The mottled gray seeds showed only 7 per cent germination in the control after 4 days, but the germination was increased to 59 per cent after steeping in 30 c.c., or 20 times their volume, of hot water. The seeds that were favorably affected by the hot water treatment seemed to germinate rather promptly. The percentage increase of the 8-day count over the 4-day is hardly significant. The increase in the control, however, was from 7 to 17 per cent.

The effect of the hot water on the gray seeds is perhaps of more importance when the data are compared with the like data from the black seeds. The initial black seeds gave only 3 per cent germination in 8 days, while there was a gradual rise in the percentage that germinated after treatment with increasing quantities of hot water. It rose from 14 to 55 per cent when the quantity of hot water was increased from 10 to 500 c.c. This comparison of the gray seeds and the black seeds shows that there was a decided difference between the two samples, despite the fact that the method of making a test of germination gave somewhat irregular results. Further, it should be mentioned that a high percentage of the black seeds that germinated within 8 days did so before the 4-day count.

The quantity of seed from California was too small to use in an extensive test. It is noteworthy, however, that 12 per cent of these seeds in the control germinated within 4 days. The germination was increased nearly 3 times by steeping in 250 c.c. of hot water, or in 165 times as much hot water as there was seed.

The favorable effect on germination of increasing the quantity of hot water suggested that a higher percentage of seeds might be induced to germinate if they were kept in a water bath at a higher temperature, and perhaps for a longer period of time. Accordingly, seeds were placed in cheesecloth squares as described under "Treatment of Seed" and dropped into boiling water. The periods of immersion together with the effect on germination can be seen in Table 2.

It is apparent that immersion of the seeds in water kept at the point of ebullition for a certain period of time was effective in inducing the seeds to germinate. An immersion period of 1 to $2\frac{1}{2}$ minutes for the sample of mottled gray seeds induced the largest number of seeds to germinate; a longer period resulted in injury. The black seeds, however, withstood an immersion period of $3\frac{1}{2}$ minutes before injury was apparent, the criterion being the reduction in number of seeds that germinated. It is evident that immersing the seeds of both samples in boiling water for at least 2 minutes induced more seeds to germinate than would have followed a steeping in 350 times their volume of hot water.

The data obtained from seeds that were soaked in concentrated sulphuric acid are shown in Table 3. The duration of the treatment ranged from 15 minutes to 24 hours. The effect of the acid treatment can be easily seen when the percentage germination of the three samples is compared with that of their controls. There was a gradual increase with time of treatment, up to 6 hours, in the percentage of mottled gray seeds that germinated. After this period of treatment the germination was 87 per cent in 4 days, and 90 per cent in 8 days. The percentage germination of the black seeds

was also increased with the time of treatment, up to 10 hours. Seeds treated for 10 hours in the acid gave 92 per cent germination at the 4-day count, and no more seed germinated in the next 4 days. The maximum germination of the seeds from California occurred after treatment of about 4 hours.

The first effect of the acid on the seeds was corrosive; the acid became dark colored, then pits began to appear in the horny covering of the seeds. These pits were easily visible after washing the seeds, and were well defined at that period of time which gave the maximum germination. A prolonged soaking of the seeds in addition to the treatment which induced maximum germination resulted in injury to the seeds of all three samples. It is noteworthy that some of the seeds could withstand such a drastic treatment for 24 hours and still germinate. The black seeds were more resistant than the gray, and the latter were more resistant than the seeds from California. The seed coats of the black seeds were slowly affected by the acid. They began to change color from ebony to gray after an exposure of 6 hours to the acid. After 10 hours in the acid the grayness was approaching the shade of the original gray seeds. Burton (1), using a sample of locust seed from Austria which he treated with concentrated sulphuric acid, records the change of color from black to gray as occurring in 30 minutes.

Discussion

From the data presented it is clear that black locust seeds gathered the same year from different trees in nearby localities differed widely in the degree of hardness of their seed coats. This was indicated by their inability to imbibe water and to

Table 1

EFFECT OF QUANTITY OF BOILING WATER AS A SCARIFICATOR OF BLACK LOCUST SEEDS

Quantity of boiling water added to 100 seeds	Percentage germination of				
	Mottled gray seeds		Black seeds		California seeds
	4 days	8 days	4 days	8 days	4 days
10 c.c.	16	18	13	14	
30 c.c.	59	61	29	31	
50 c.c.	28	30	28	29	
100 c.c.	44	45	29	34	
250 c.c.	38	45	29	36	34
500 c.c.	49	53	41	55	
Control	7	17	2	3	12

Table 2

EFFECT OF IMMERSION TIME IN BOILING WATER ON THE GERMINATION OF BLACK LOCUST SEEDS

Time in boiling water	Per cent germination of					
	Mottled gray seeds			Black seeds		
Minutes	5 days	8 days	10 days	5 days	8 days	10 days
½	35	64	65	22	60	78
1	58	72	73	47	78	93
1½	60	72	76	55	81	84
2	45	70	74	21	79	90
2½	39	69	72	44	86	92
3	16	35	35	43	69	80
3½	42	49	49	33	83	90
4	27	31	38	46	81	84
5	15	28	31	27	59	70
6	12	22	28	42	50	59
Control	7	17		2	3	

germinate. One collection gave 3 per cent germination in the control in 8 days, another 12 per cent, and a third 17 per cent. The seeds gave an increase in germination after scarification by steeping in hot water, by immersing in boiling water, and by soaking in concentrated sulphuric acid. Steeping the seeds in hot water, however, was not as effective as immersion in boiling water or soaking in concentrated sulphuric acid. The largest percentage to germinate in 8 days in one sample treated with hot water was 34, while the largest for the same seed soaked in the acid was 56. In a second sample from other trees the percentage of seeds that germinated was 61 for steeping in hot water, 76 for immersion in boiling water, and 82 for soaking in concentrated sulphuric acid. In a third sample the percentages of seeds that germinated were 55, 93, and 92 for the three treatments respectively. Such data indicate that the ineffectiveness of the hot water was due to a rapid lowering of the temperature of the water when it comes in contact with the seeds, so that the temperature was not sufficient to scarify the more resistant seed coats. It does not scarify sufficiently to permit water to penetrate to the embryos and start germination. It is assumed that this accounts for the findings of Burton (1), who states that the effect of treating Idaho black locust seeds with hot water was negligible.

The mottled gray seeds and the black seeds that were immersed in boiling water for varying periods of time showed a significant increase in the percentage of seeds that germinated. For the gray seeds the increase was from 17 per cent in the control to 73 per cent after 1 minute in the boiling water, and for the black seeds from 3 per cent to 93 per cent. An immersion period for the gray seeds longer than 2½ minutes resulted in injury, while the black seeds withstood this treatment for 3½ minutes.

The seed that was treated for varying periods with sulphuric acid showed a gradual increase in the percentage of seeds that germinated. This period of time for one sample was about 4 hours,

TABLE 3

EFFECT OF SULPHURIC ACID AS A SCARIFICATOR OF BLACK LOCUST SEEDS

Period of treatment (hours)	Percentage germination of: Mottled gray seeds, 4 days	Mottled gray seeds, 8 days	Black seeds, 4 days	Black seeds, 8 days	California seeds, 4 days
¼	23	28	10	13	
½	22	32	10	12	
¾	50	54	31	36	
1	65	68	43	46	28
1½	60	62	39	40	
2	58	60	50	53	40
3	66	72	55	65	
4	63	65	63	70	56
5	77	80	81	83	
6	87	90	84	85	12
8	81	82	84	90	
10	77	79	92	92	
12	63	66	85	86	
14	57	57	82	83	
16	69	69	86	87	
18	61	62	83	83	
20	18	18	82	82	
22	51	58	84	86	
24	28	33	65	65	
Control	7	17	2	3	12

for another 6 hours, and for a third 10 hours. A further exposure of the seeds to the acid resulted in injury, as was indicated by reduced germination.

These data are interesting when compared with those obtained by Burton (1), who conducted extensive tests on the germination of black locust seeds. He scarified seed by chipping them on one side with a sharp knife, and obtained 62 per cent germination. These seeds were harder than certain other seeds that he also employed in the tests. If he soaked the seeds in concentrated sulphuric acid for 30 minutes, he obtained only 17 per cent germination. This is about the same as he obtained in the controls. He might have obtained a larger germination than 62 per cent if he had soaked the seeds in acid for a considerably longer period than 30 minutes.

Summary and Conclusion

Seeds of black locust were obtained from three localities. They were all of the 1934 crop, but represent seeds from trees of different inherent characteristics but with approximately the same content of moisture. They were scarified by employing hot water, by immersion in boiling water, and by soaking in concentrated sulphuric acid. Tests of the power of the seeds to germinate were the criteria of the effectiveness of the methods of scarification. The data obtained lead to certain conclusions.

A study of only three samples of seed may not have given sufficient data from which to make definite recommendations for treating black locust seeds to hasten germination, but it does suggest that for maximum germination with sulphuric acid used as a scarifying agent, the seeds, if sufficiently dry, should be soaked in the acid for a much longer period of time than has been generally recommended. The study also indicated that immersing the seeds in boiling water for from 1 to 2½ minutes will induce about the same number of seeds to germinate as if they had received the longer treatment in sulphuric acid.

The germination of such untreated seeds varied from 3 per cent with one sample to 17 per cent with another. By employing sulphuric acid as a scarifying agent, the germination of one sample was increased to 90 per cent or more. The immersion period varied for seeds from trees of different inherent characteristics. For seeds of one degree of hardness it was 4 hours, for seeds of another 6 hours, and for those of still another 10 hours.

The hot water method of scarification was more effective with seeds from one environment or from individual trees than from another environment or from other trees. On account of the large volume of water necessary for effective scarification, this method may not be practical when large quantities of seed are to be treated. Measured in terms of seeds that germinated after treatment, it is not as effective as an immersion of 2 minutes in boiling water, or a soaking in sulphuric acid for several hours.

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DISTRIBUTION OF FOREST TREE ROOTS IN NORTH CAROLINA PIEDMONT SOILS[1]

By T. S. COILE

Duke Forest, Duke University

THE root systems of forest trees are of interest in the study of forest soils because of the intimate association between the soil and the roots of the trees, and the effect of soil properties on the absorption of water and nutrients. We know that certain species of trees have characteristic rooting habits, and that soil conditions affect the growth and development of stands through their influence on the tree root systems.

Studies of the root systems of forest trees whose objectives have been the evaluation of the differences between various species, and the effect of various soil conditions on root development, have been largely qualitative in the past. Emphasis has been placed on drawings of "typical" root systems of individual trees, which have often been three-dimensional figures on two-dimensional surfaces. The root systems of entire trees have been excavated and drawn to scale, but the physical difficulty of obtaining a large amount of data makes the use of this method definitely limited.

Studies of forest-tree root systems have been influenced to a certain degree by the methods used in studying root systems of grassland plants, whose direction of elongation may be primarily downward.

In connection with routine soil studies in the Duke Forest, the writer has followed the practice of mapping all the roots on one profile face of each soil well dug, for whatever purpose. The transects are two-dimensional, and show the soil horizons and the diameters and position of roots. The roots are mapped in cross section only, no attempt being made to show direction or the angle of the long axis of the root. A rather large amount of quantitative data has been collected on the vertical distribution of roots of various sizes in different forest types, age classes, and soil conditions, of which some of the more outstanding are included here.

The soils of the Piedmont Plateau belong in the red and yellow soil groups (4). Where erosion has not been overly active the residual soils have well developed profiles; that is, well defined A and B horizons are discernible. The soil developed from first-bottom alluvium, largely belonging to the Congaree series in this locality, does not usually have well defined horizons, but is composed of stratified layers of sediment varying in thickness and continuity, and in textural grade from sands to clays.

In a study of the relative importance of root competition as compared to competition for light, 7 pairs of milacre sample plots were located in 1932 and 1933 in 5 different forest types. One of each pair of plots was isolated from the roots of surrounding trees by a trench 3 or more feet in depth and about 18 inches wide. The trenches were dug deep enough to cut off essentially all roots entering the milacre plots. While the trenches were open the location of the various soil horizons and the location and diam-

[1] Paper presented at the annual meeting of the American Soil Survey Association, Washington, D. C., November 17, 1936; published as an addition to the "Forest Soil Symposium," JOURNAL OF FORESTRY, 35:4-39.

eter of all roots entering or leaving the plots were mapped to scale on the outside wall of the trench. The total length of outside trench wall for the plots varied from 45 to 48 feet. Plots were trenched in the following forest types: loblolly pine (*Pinus taeda* L.), 10-year and 35-year old stands (two sets of plots were located in the latter); shortleaf pine (*P. echinata* Mill.), 50 years old; post oak—blackjack oak (*Quercus stellata* Wang., *Q. marilandica* Muench.), 20 to 40 years; white oak—black oak—red oak (*Q. alba* L., *Q. velutina* LaMarck., *Q. borealis* Mich.), uneven-aged; and red gum—yellow poplar (*Liquidambar styraciflua* L., *Liriodendron tulipifera* L.), uneven-aged.

Table 1(A) gives the vertical distribution of the various size-classes of roots from the trees in a 35-year-old loblolly pine stand growing in Alamance slaty loam. There is a preponderance of the smallest size-class of roots (<0.1 inch in diameter) near the surface. The location of this size-class of roots is of special interest because it indicates the location of the greatest water absorbing surfaces. Of additional interest is the dearth of roots in the C horizon. The table shows the number of roots of each size-class per square foot of profile face, along with the textural grade, area, and depth of the various horizons. This area was formerly cultivated and was subjected to considerable sheet erosion as evidenced by the relative thinness of the A horizon, 5 inches, and the accumulation of much slate-like rock on the surface. The B horizon varies in texture from silty clay to clay; it is plastic when wet. The C horizon is made up of disintegrating fine-textured basic rock of the Carolina slate belt. The profile is in general shallow, and the B horizon is often absent or poorly developed, indicating a relatively young soil. The physical nature of the C horizon and its nearness to the surface are not conducive to deep root penetration. The character of the fully stocked 35-year-old stand of loblolly pine can be seen in Figure 1. In one part of this stand, where the C horizon is encountered 12 inches from the surface, the site index is 75, while in another part, where the soil is 24 inches deep, the site index is 91, a difference of 16 feet in site quality (50-year age base).

Another milacre trenched plot was located in the same stand the following year (1933). The number and distribution of the various diameter-classes of roots in the different horizons was essentially the same as shown in Table 1(A).

The vertical distribution of roots in the various diameter-classes from trees in a dense stand of loblolly pine, 10 years old, is indicated in Table 1(B). The stand has approximately 20,000 trees to the acre. The soil is an Alamance slaty sandy loam. The horizon designated as A is really a "plowed horizon" whose depth, physical characteristics, and organic matter content have been conditioned by past agricultural practice. Ridges of former cultivation rows still persist on the surface. The soil has not acquired the characteristics of a forest soil, and the network of roots near the surface has not reached a stage of equilibrium characteristic of middle-aged pine stands. The root transact is characterized by few large roots throughout the profile, and few small roots near the surface as in older stands.

The vertical distribution of the roots of the trees in a 50-year-old stand of shortleaf pine growing in White Store sandy loam is similar to that of the loblolly pine type. There are many small roots near the surface of the mineral soil, and few roots in the lower part of the profile (Table 1(C)). The stand is fully stocked and has a well developed understory of hardwoods. The soil is developed from fine-textured Triassic sandstone, and has a characteristic coarse-textured A hori-

Fig. 1.—Oldfield loblolly pine, 35 years old, fully stocked.

zon and a heavy, compact, plastic clay B horizon. In general the physical nature of the B horizon makes it unfavorable for root growth. The White Store soils support shortleaf pine stands of extremely wide site-index range (1). When heavily eroded, so that the B horizon is at or near the surface, they support very poor stands of shortleaf pine.

The vertical distribution of roots from trees of the post oak—blackjack oak forest type growing in Orange loam is shown in Table 1(D). The Orange soil when relatively shallow, as in this instance, presents rather inhospitable conditions for the hardwood forests of the region. The clay of the B horizon is extremely plastic, and water movement through it is slow because the colloidal material swells on wetting, closing waterways for percolation. Water movement, either downward or upward, is slow through the B horizon. The physical natures of the B and C horizons are not conducive to good root development. Moisture conditions are often adverse during the growing season, and the xeric oaks characteristic of the stand have a stunted appearance. The usual understory of mesic hardwoods is strikingly absent.

An unusual comparison can be made between the distribution of roots in the Orange loam and the distribution of roots from trees in the white oak—black oak—red oak type growing in Georgeville clay (Table 1(E)). There are over three times as many small roots per square foot in the A_1 horizon of the latter, and they penetrate to relatively great depths. The red Georgeville soil has developed

Fig. 2.—Uneven-aged stand of the white oak—black oak—red oak type growing in Georgeville soil.

from old basic igneous rock and has weathered to considerable depth. The open, friable character of the red clay in the thick B horizon is conducive to good water percolation, aeration, and root development. The character of the stand is shown in Figure 2.

The Congaree soil series shows little profile development except a deep A_1 horizon. A striking feature is the large number of small roots in the deep A_1 horizon. A mull humus type is developed under the red gum—yellow poplar forest, as compared to a mor humus type under the oak stand on the uplands. The deep penetration of all roots is especially noticeable in this soil, which is characterized by stratified recent sediments and a fluctuating water table. Soil moisture and aeration are favorable for root growth. The number of roots in each horizon per square foot of profile face is given in Table 1(F). The stand is shown in Figure 3.

In Figure 4 the number of roots less than 0.1 inch in diameter per square foot in each horizon is shown for the seven sets of trenched plots discussed above. In the top figure the heavy network of small roots near the surface in the white oak—black oak—red oak forest type on Georgeville clay is contrasted with a much smaller number in the post oak—blackjack oak type on Orange loam. The large number of small roots throughout the Congaree soil supporting the red gum—yellow poplar type is contrasted with all the other soil conditions and forest types. The bot-

TABLE 1

NUMBER OF ROOTS IN 5 DIAMETER SIZE-CLASSES PER SQUARE FOOT OF VERTICAL FACE ON A TRENCH.

Horizon	Average depth (inches)	Area (square feet)	Textural grade	Root diameter classes—inches: < 0.1	0.11 to 0.30	0.31 to 0.50	0.51 to 1.0	1.1+
(A). In a 35-year-old stand of loblolly pine								
A_1	0 to 1.0	3.75	Loam	105	12	0.53	0.26	0
A_2	1.0 to 5.0	11.25	Loam	55	11	1.6	0.53	0.35
B_1	5.0 to 15.0	37.50	Clay	4.0	1.9	0.05	0.05	0
B_2	15.0 to 21.0	22.50	Clay	5.3	2.1	0	0	0
C_1	21.0 to 37.0	60.00	Clay	0.20	0.80	0.02	0	0
(B). In a 10-year-old stand of loblolly pine								
A	0 to 7.5	28.00	Sandy loam	44	6.8	0.21	0	0
B	7.5 to 18.0	40.00	Loam	15	0.75	0	0	0
C	18.0 to 36.0	76.00	Sandy clay	3.6	0.18	0	0	0.03
(C). In a 50-year-old stand of shortleaf pine								
A_1	0 to 1.7	6.40	Sandy loam	75	12	1.2	0	0
A_2	1.7 to 7.5	21.60	Sandy loam	12	8.2	0.93	0.60	0
B_1	7.5 to 17.0	36.00	Clay loam	2.6	1.8	0.11	0.17	0
B_2	17.0 to 33.0	60.00	Clay	1.3	1.3	0.03	0	0
C_1	33.0 to 38.0	20.00	Clay	0.40	0.40	0	0	0
(D). In a 20- to 40-year-old stand in the post oak—blackjack oak forest type								
A_1	0 to 2.0	8.00	Loam	62	8.0	0.62	0.50	0
A_2	2.0 to 8.5	26.00	Clay loam	33	5.6	0.85	0.35	0.23
B	8.5 to 20.0	46.00	Clay	3.7	1.3	0.37	0.20	0.04
C	20.0 to 31.0	44.00	Clay	0.41	0.18	0.05	0	0
(E). In an unevenaged stand in the white oak—black oak—red oak forest type								
A_1	0 to 2.0	8.00	Clay	201	24	0.88	0.12	0.12
A_2	2.0 to 5.0	12.00	Clay	47	16	1.6	0.17	0
B	5.0 to 31.0	104.00	Clay	4.4	1.7	0.18	0.05	0.03
C	31.0 to 36.0	20.00	Clay	3.2	0.25	0	0	0
(F). In an unevenaged stand in the red gum—yellow poplar forest type								
A_1	0 to 4.0	16.00	Sandy clay loam	118	9.4	0.62	0	0.06
2	4.0 to 19.0	60.00	Sandy loam	17	5.0	0.60	0.38	0.30
3	19.0 to 49.0	120.00	Sandy loam	8.7	1.5	0.08	0.02	0.08

Fig. 3.—Uneven-aged stand of the red gum—yellow poplar type growing in Congaree soil.

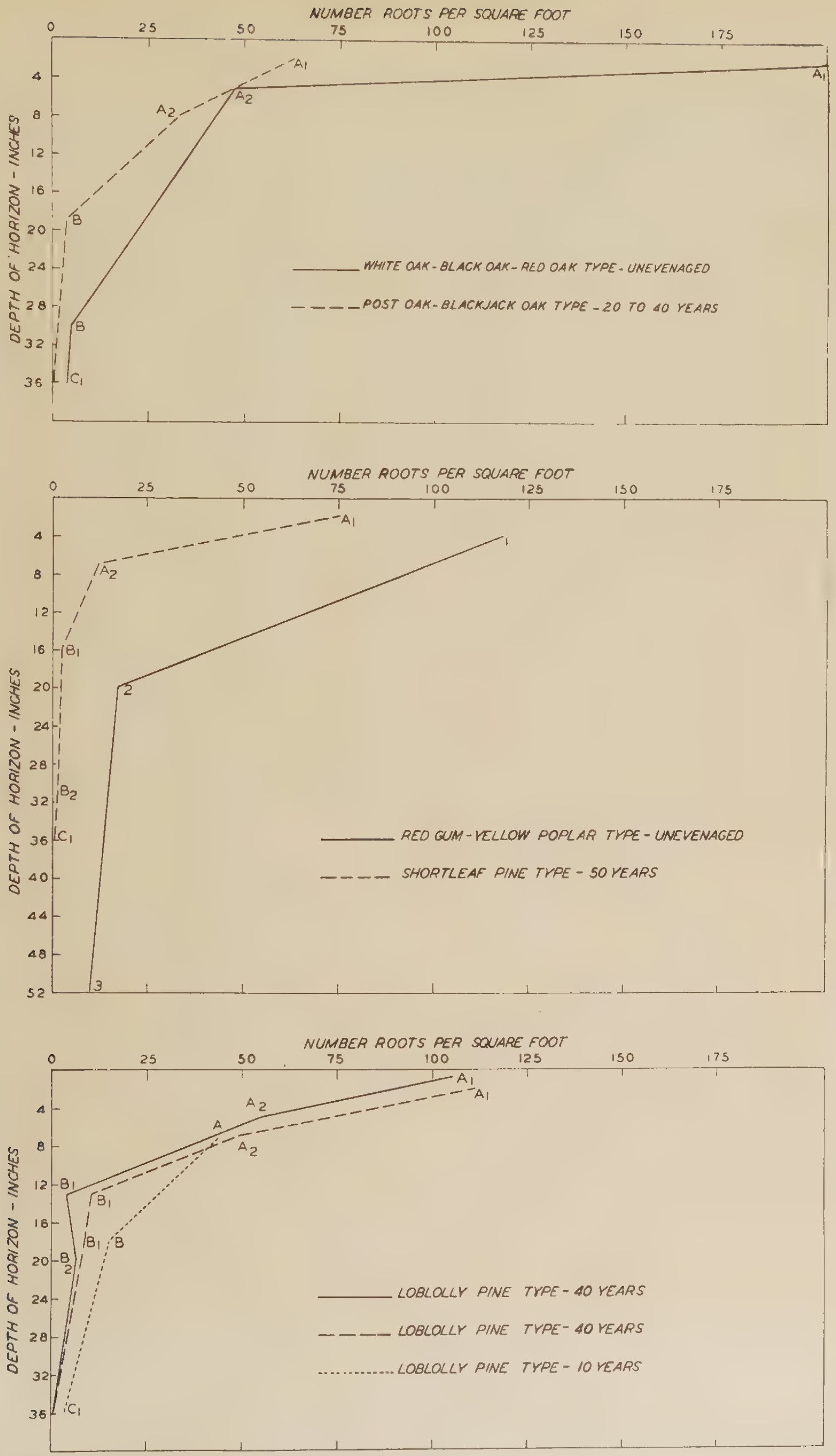

Fig. 4.—Number of roots less than 0.1 inch in diameter per square foot of each soil horizon in 5 forest types.

tom figure shows the close agreement found between the number of small roots in each horizon at different places in the same stand of loblolly pine growing on Alamance loam. The incomplete development of the network of small roots near the surface of the soil under a 10-year-old stand of loblolly pine is apparent.

In connection with a study of soil changes associated with the succession of loblolly pine on abandoned Georgeville and Alamance soils, the distribution of the various size-classes of roots was mapped on the profile face of soil wells. In Figure 5 the number of roots per square foot (less than 0.1 inch diameter class) in each horizon is plotted over age in years, using the age class of the even-aged pine as a base. The uneven-aged white oak—black oak—red oak type is representative of the oak—hickory climax forest on the best upland soils in this part of the Piedmont region. The large number of small roots in the A_1 horizon is very apparent throughout the successional series. It is evident in the pine stage of the series that the number of roots in the A_1 horizon increases rapidly with age until the stands are between 20 and 30 years old. The increase after 30 years is much smaller. The oldest loblolly pine stand available for study was 70 years old, so that there is a long break for which no data are available between this age-class and the uneven-aged oak, the dominant trees of which are between 150 and 200 years old. Three hundred years for the oak, then, is merely an estimate of the time between the beginning of pine and the present oak stand. The great number of roots in the A_1 horizon under the oak forest contrasts markedly with that of the oldest pine.

The number of roots in the A_2 horizon follows the same trend as in the A_1 horizon, although the numbers are greatly reduced; while in the B and C horizons the number of roots remains constant after about the 20-year age class of pine.

The studies of root distribution that have been discussed are all concerned with the number of roots in each size-class in each soil horizon of a profile. In connection with a study of nitrogen transformation in the surface soils under a 110-year-old stand of shortleaf pine on White Store sandy loam and an uneven-aged stand of red gum and yellow poplar on Congaree silt loam, the oven-dry weight of roots in the surface soil to a depth of 4.5 inches was determined by diameter-classes of roots. In each stand four 2 by 2 Latin squares 20 feet square were located at random and 9 pints of soil were taken systematically in each subplot. All of the roots from 9 pints of soil were collected, divided into size-classes, dried, and weighed. Analysis of variance (Table 2) showed the difference between the weight of roots (less than 0.1 inch class) in the shortleaf pine stand (Figure 6) and the red gum and yellow poplar stand (Fig-

TABLE 2

ANALYSIS OF VARIANCE OF WEIGHT OF ROOTS (GMS.) IN 9 PINTS OF SURFACE SOIL. LESS THAN 0.1 INCH SIZE-CLASS. 110-YEAR-OLD SHORTLEAF PINE TYPE AND UNEVENAGED RED GUM—YELLOW POPLAR TYPE

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	7	24.5681	
Between means of plots	3	0.5322	0.1774
Between means of types	1	0.0061	0.0061
Error	3	24.0298	8.0099

$$F = \frac{0.0061}{8.0099} = 0.008; \text{ F for P} = .05 = 215.72$$

Mean weight in grams of 16 samples
Shortleaf pine type = 8.06 ± 1.11 gms.
Red gum—yellow poplar type = 8.10 ± 0.58 gms.

Mean difference = 0.04 gms.
Standard deviation of mean difference = 1.08

ure 3) to be insignificant (2, 3, 5, 6). The mean weight of roots in the smallest size-class was 8.06 gms. in the shortleaf pine stand, and 8.10 gms. in the red gum—yellow poplar stand. The weight of roots in the 0.11- to 0.30-inch class in the shortleaf pine stand was 8.08 gms. and in the red gum—yellow poplar stand 6.92 gms., but the difference is not significant statistically (Table 3).

The variance of root weights between composite samples within the 2 by 2 Latin squares and between the randomized plots was insignificant in the surface soil under the red gum—yellow poplar forest type. The area can be considered homogeneous as far as the weight of the small roots are concerned. However, in the shortleaf pine stand there was a significant variation between the means of plots, but the variation within plots was well within that attributable to chance. The differences between mean plots are associated with a difference in textural grade of the surface soil, due to erosion.

Although the two forest types and soil conditions compared above are quite different, the average weight of small roots in similar volumes of soil from each area was essentially the same. This condition suggests to the author that after fully stocked forest stands have reached a certain age the number or weight of the small size-classes of roots in the surface soil reaches a near constant. Under given forest and climatic conditions this

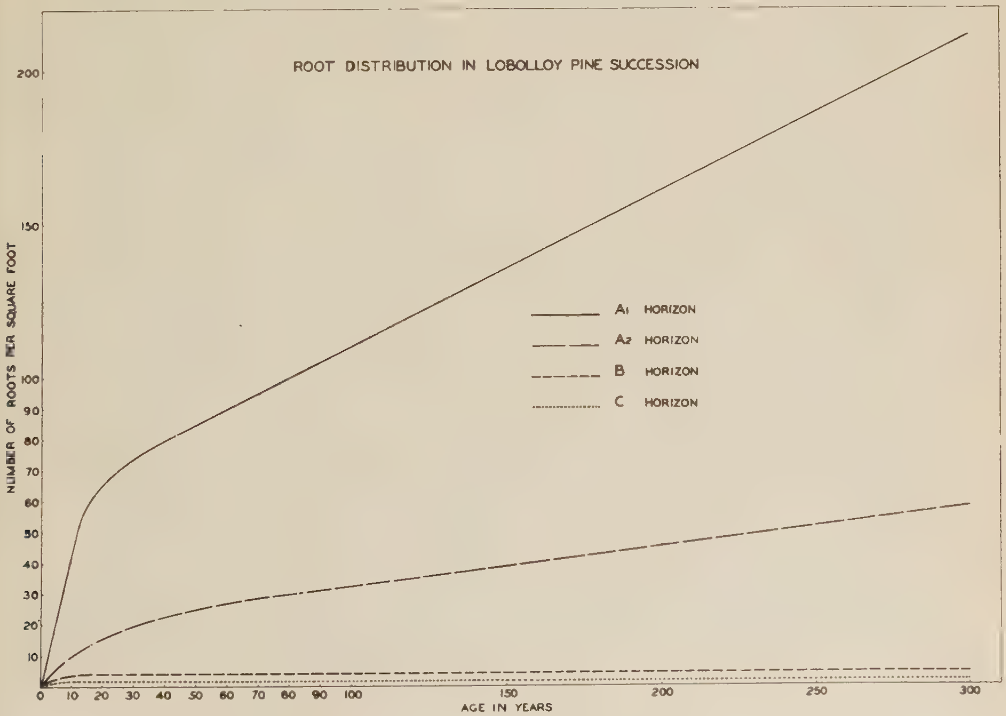

Fig. 5.—Number of roots less than 0.1 inch in diameter per square foot of each soil horizon, under stands of loblolly pine up to 70 years old and in an unevenaged stand of the white oak—black oak—red oak forest type in Georgeville and Alamance soils.

Fig. 6.—Shortleaf pine stand 110 years old.

TABLE 3

ANALYSIS OF VARIANCE OF WEIGHT OF ROOTS (GMS.) IN 9 PINTS OF SURFACE SOIL. 0.11 TO 0.30 INCH CLASS. 110-YEAR-OLD SHORTLEAF PINE AND UNEVENAGED RED GUM—YELLOW POPLAR TYPE

Source of variation	Degrees of freedom	Sum of squares	Mean square
Total	7	8.90	
Between means of plots	3	2.64	0.880
Between means of types	1	4.66	4.660
Error	3	1.60	0.533

$$F = \frac{4.660}{0.533} = 8.74; \text{ F for } P = .05 = 10.13$$

Mean weight in grams of 16 samples
Shortleaf pine type = 8.08 ± 0.32 gms.
Red gum—yellow poplar type = 6.92 ± 1.06 gms.

Mean difference = 1.16 gms.
Standard deviation of mean difference = 1.85

might be considered the *root capacity* of the soil. The two soils and forest types discussed last appear to be similar in this respect; however, it is likely that the surface soil of the Georgeville series under the white oak—black oak—red oak forest would have a larger weight of roots in the small diameter-classes per unit volume.

The viewpoint expressed above is entirely logical when we consider that, if rainfall and other conditions are similar over a growing season, a given volume of soil can support only a given amount of absorbing surface. It is probable that a maximum is attained under the undisturbed climax forest, and it is an important factor in the occlusion of many species of the subclimax forest whose superficial initial root system may not be able to compete with the already established climax species for available moisture and nutrients during the growing season.

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FACTORS AFFECTING ASIATIC CHESTNUTS IN FOREST PLANTATIONS[1]

By J. L. Bedwell[2]

THE commercial stands of our native chestnut are undergoing certain destruction by ravages of chestnut blight, an introduced disease caused by the fungus *Endothia parasitica* (Murr.) A. and A.

Chinese chestnuts (*Castanea mollissima* Bl.) and Japanese chestnuts (*C. crenata* Sieb. and Zucc. syn. *C. japonica* Bl.) growing in orchards in the United States have exhibited considerable natural resistance to chestnut blight. Experimental forest plantings of these two species were set out in 1930 and 1931 from New Hampshire to Texas and from Iowa to Florida to determine the feasibility of growing these exotics. In the two years 188,223 Japanese and 14,550 Chinese chestnut trees were distributed for planting. The trees were grown from seed in the nursery at Glenn Dale, Md., and were sent out as 1-0 and 1-1 stock ranging from 12 to 36 inches in height. The planting was done by cooperators consisting of the U. S. Forest Service, state forestry departments, state park commissions, state game departments, university forestry schools, city foresters, foresters employed by railroads, tannin extract and chemical companies, and others. One hundred and sixty-two separate plantings were made.

These plantations with but a few exceptions were inspected by the writer each year from 1930 to 1933 inclusive, and data were taken on the survival, thrift, blight resistance, and factors affecting the trees in the first few years after planting. Very little difference was found on the whole between the Japanese and Chinese chestnuts as far as survival, thrift, and the effect of different factors operating in the plantations is concerned. The data for 112 of these plantations have been compiled and a few of the more important factors are discussed in this paper.

Dieback

Under the general term dieback have been included all injuries that cause similar gross symptoms and need no separation. The four factors included in this category in order of importance are drought, twig blight, low-temperature injury, and planting injury. These factors were responsible for the death of 57 per cent of the Japanese and 55 per cent of the Chinese trees. Twenty-six plantations had from 76 to 100 per cent, 22 had 51 to 75 per cent, 49 had 11 to 50 per cent, and 5 had 1 to 10 per cent of trees killed by "dieback."

Drought.—This was an important and serious factor in 1930 in many of the plantations, and in a few in 1931. Mortalities caused by drought were especially heavy in 1930 in the plantations at Moulton, Ala., Athens, Ga., Big Pool, Md., Boyce, Va., Bridgewater, Va., Hot Springs, Va., and Marlinton, W. Va.; and in 1931 at Athens, Ga., Concord, N. C., Aiken, S. C., Florence, S. C., Liberty Hill, S. C., Nashville, Tenn., and Marlinton, W. Va. For the whole period of observation this climatic factor accounted for the death

[1]Much of the discussion herein presented is based on data which were included in a dissertation submitted to the faculty of the Graduate School of Yale University (Yale Forestry School) June 1932, in partial fulfillment of the requirements for the degree of doctor of philosophy.

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of 32 per cent of the Japanese and 34 per cent of the Chinese trees out of a total percentage listed under "Dieback" of 57 and 55, respectively.

Twig Blight.—This is a dieback and canker disease caused by, or at least associated with, several species of fungi belonging to the order Sphaeropsidales. The writer has found and identified seven different fungi causing or associated with this disease. This factor has been covered in another paper[3] and is, therefore, only mentioned here. An appreciable amount of the killing listed under dieback is attributable to twig blight.

Winter Injury.—Winter injury includes injuries caused by low temperatures, including late and early frosts. Asiatic chestnuts appear to be quite susceptible to injury by low temperatures at the end of the growing season when heavy frosts occur before the twigs and buds are sufficiently matured and hardened. In the winter or early spring this injury has also appeared after unseasonably warm weather followed by a spell of low temperature. These chestnut trees have also been injured by frost late in the spring, after the leaves are out and new tender shoots have been produced. Actually only a very small amount of this type of injury was recorded in the forest plantings. It is definitely known that severe injury was caused by frost in the plantation at Cashiers, N. C., the latter part of May, 1931, at Belleplain, N. J., in early June, 1931, and at Corinth, N. Y., on the night of July 8, 1932. At the time these places were inspected, however, all external traces of the freezing injury had been concealed by the development of twig blight on the injured trees. At Highlands, N. C., 4 per cent of the trees were found killed by freezing during 1931. This is the only place where freezing injury was recorded.

Planting Injury. — Under the heading of planting injury were listed injuries due directly to the planting operation and not to factors operating after the trees were set out in the permanent site. By reason of the experimental nature of these plantings and of the very high type of cooperators involved, unusually good planting jobs were obtained in most cases. When the planting was done by inexperienced crews and with poor supervision, the trees were more likely to be set at improper depths and the soil not well firmed about the roots, resulting in considerable loss. For real success in plantings the writer is convinced that too much stress cannot be laid on the importance of experienced crews, under strict and conscientious supervision.

Cases of injury or death which were classed as being due mainly or entirely to the planting were found to result from one of the following:

(a) Shallow planting. This was the most common type of careless planting found. Numerous cases were noticed where trees were set with from 3 to 6 inches of the crown and roots above the surface.

(b) Deep planting. Not nearly so many cases of this were found, nor were the results so injurious, at least at the time of the inspection, as those that were set too shallow.

(c) Soil not compacted around the roots. This was a rather common occurrence on those plantations where careless planting was recorded.

(d) Improper planting method. One entire planting was a total loss mainly from this cause. The cooperator had driven the planting holes with a crowbar in wet, heavy soil. After the plant had been inserted in the hole, the crowbar was driven down alongside and pulled over to close the hole. This merely closed the top, leaving an air pocket around the lower roots in addition to the

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[3]Bedwell, J. L. 1934. Portion of Ph. D. dissertation entitled "Twig Blight of Asiatic Chestnuts" to be submitted for publication in Phytopathology.

crowbar hole alongside the plant. Several cases of air pockets left around the roots were also observed when the slit method was used in heavy soil or in deep sod.

(e) Wrong planting season. Plantings made in some of the southern states in the late spring, after dry weather had set in, gave very low survivals. This was not the fault of the cooperators. By the time the weather permitted the trees to be dug in the nursery at Glenn Dale, Md., the season was too far advanced in states farther south. Plants intended for spring planting in that region should be raised in local nurseries where climatic conditions permit digging the trees at the proper time for field planting.

Prevention of losses from factors causing dieback is obviously no simple matter in forest plantings. It was noticed that trees planted under partial or low shade and where competition was not too great suffered much less from drought. Trees planted on the north side of stumps, rocks, logs, or snags, and those under open natural vegetation such as aspen, willows, and alders, were examples. This protection from direct sunlight during the heat of the day reduces plant transpiration and soil evaporation.

To reduce the amount of low-temperature injury, frost-hardy strains should be selected if available, or the plantations should be located on north slopes or other exposures where spring growth will be retarded until danger from frost is past. Low, poorly drained hollows, the so-called "frost pockets", should be especially avoided. Reasonable escape from twig blight can be assured if thrifty stock is planted on good sites, where vigorous growth can be maintained, and the trees are protected from injuries. Injuries and wounds of any kind make excellent entrance points for twig-blight organisms as well as for heart-rotting and other fungi. The trees should be planted in proper season, the correct planting method should be used for the particular site selected, and only experienced crews should be employed, under strict and conscientious supervision. The above rules might well be observed in the planting of any hardwood, and most of them in the planting of conifers also.

Rabbits

Rabbit injury could be recognized by the characteristic smooth diagonal cut which, on close examination, showed the teeth marks. These injuries ranged from the cutting off or nibbling of the small twig tips to the complete excision of the tree near or at the ground line. Other cases were found where rabbits had girdled the trees or removed strips of bark from them. Most rabbit injury occurred in places where tall grass, brush, or sprouts served to shelter the animals from their natural enemies. Very little damage occurred in open, exposed places.

Rabbit damage was found at 94 per cent of the plantations, with injuries to living trees in some places as high as 80 per cent of the stand, and with trees killed at 60 per cent of the plantations, the loss ranging from 30 to 80 per cent.

The largest percentage of trees killed in any one state was in Arkansas. States having the most universal distribution of damage were Connecticut, Indiana, Maryland, Mississippi, New Jersey, New York, North Carolina, Pennsylvania, Tennessee, and Virginia.

What is perhaps more signficant than the percentage killed for a plantation as a whole is the amount of group-wise damage done. The percentage of trees killed at many places may not appear to be serious, but in several cases such a supposition is erroneous. If the injury occurred only here and there in a plantation, the result might be compared to a thinning and the losses held negligible. As a matter of fact, however, rabbits concentrated their efforts in certain parts of the plantation and as a result large

patches were found where, for some distance, all of the trees in adjacent rows had been attacked by these rodents.

These chestnuts will generally produce vigorous sprouts when cut off at the root collar or just above it. In such cases the damage is not so serious as the repeated cutting off of the twigs in the top of the tree and the stripping off of the bark from bole and branches, which are the most frequent types of injury.

Mice

The plantations were injured by both pine mice and meadow mice. There were two types of injury. The meadow mouse feeds mostly at the surface, but the pine mouse is a burrowing animal and feeds almost entirely underground. A significant amount of injury and killing of Asiatic chestnut seedlings by pine mice formerly occurred annually in the nursery at Glenn Dale. Through the efforts of the Biological Survey these pests have been controlled satisfactorily.

The injury above ground was characterized by gnawing of the bark of the upper crown and lower bole to complete girdling of these parts by entire removal of the bark. Underground the injury was due to the gnawing of bark from the crown and roots, or cutting off of roots even up to about one-half inch below the ground surface. Teeth marks were always present as a confirming symptom in classifying this injury. In taking the field records no distinction was made between the two types of injury. It was quite noticeable that damage was concentrated along mole runs, under leaves and other debris, and in tall grass and weeds. At practically every plantation most of the injury by mice occurred the same year the trees were planted.

Injuries by mice were recorded at 46 per cent of the plantations, with trees killed at 29 per cent. Several plantations had from 10 to 39 per cent of the trees killed. The most outstanding example of serious mouse injury was found at Oakland, Md., where in 1930 over 57 per cent of the Japanese chestnuts were attacked and 26 per cent were killed. In 1931 over 19 per cent of the remaining trees were attacked, and these were all killed. The Chinese trees were affected almost as severely. Other places where considerable mouse injury was recorded were Waldron, Ark., Ames, Iowa, Canton, N. C., and The Plains, Va.

Grazing

Damage by grazing animals occurred at only eight of the plantings, but the percentage of trees killed was very high at a majority of the places where grazing had taken place. Cattle and hogs were the chief offenders, with goats guilty at one place and mules at another. Deer damage was slight, trees being killed by them at only two places. At other areas where deer were numerous the plantations were enclosed by deer-proof fences.

Chestnut Blight

In the early stages of the investigation of the chestnut blight it was believed that the Japanese chestnut was immune to this disease. It has been well demonstrated since that time, however, that trees of this species are not entirely immune. The blight is not an important factor with very young plants, but infection is more likely in trees over 4 years old. There is evidence, however, that Japanese as well as Chinese chestnuts, when planted on good sites and accompanied by good growing conditions, are highly resistant. In the plantations trees were killed by blight at only nine places, and at only two did the trees killed equal 0.5 per cent of the number planted.

Other

Factors of lesser importance, as far as these experimental plantings are concerned, are insects, leaf fungi, mechanical injuries (other than those charged to

rodents or grazing), suppression, erosion, fire, missing, and unknown.

Difficulties in Planting Exotics

When introduced into a new environment a plant meets many vicissitudes. From the begining of this study of Asiatic chestnuts in forest plantings, the writer has been confronted with the glaring examples of failures of forest plantings of native hardwoods and the scarcity of those that can be called a success. The same is true for most exotics, both hardwoods and conifers. Before the end of the rotation necessary to yield the products for which the planting is intended, the trees apparently become stagnated or are attacked by insects or diseases. Occasional plantations of native or introduced hardwoods are mentioned as exceptions, but in most cases these are found to be very young or have had special care during and following the planting operation, and almost invariably they are planted on specially selected sites for demonstration or arboretum purposes. Again, it has been pointed out that, in the case of exotics at least, even should the plantation be successful to the end of the rotation, it would probably not reproduce itself. This would require a system of clear cutting and planting at the end of each rotation.

In much of the region included in the natural range of chestnut the poorer sites are often occupied by conifers. This is noticeably true on sites having poor soil and on old fields. On these old fields the natural succession seems quite often to be conifers at first, followed later by hardwood species. In the natural succession of hardwoods, the native chestnut is represented in the later stages and in the climax. When site factors have been seriously changed by denudation and cultivation, with the resulting depletion of nutrients and erosion of the top soil and humus, the land is not the same as it was just prior to clearing. To attempt to leap this succession and establish the climax by planting hardwoods, even in mixture with conifers, does not appear to be a logical procedure.

Foresters will doubtless concede that little is known in this country about planting hardwoods as compared to conifers, and that consequently such planting, even of native species, is likely to encounter many difficulties, so that it will require much time and work to be placed on a successful basis. In planting exotics the above-mentioned problem of selection of suitable sites is ever present, and in addition the probably even more enigmatic one of seed selection. When buying seed from distant regions or foreign countries the purchaser must rely upon the honesty and ability of the collector to furnish seed collected at the proper time from the desired elevation and place of origin. Even if these specifications are complied with, the percentage of purity and germinative capacity of the seed are sometimes disappointing. European foresters have found that variations in the characteristics of the mother tree may be transmitted through the seed. Another point which must be considered in the introduction of a tree species into a new region or country is the possibility of its being susceptible to attack by native diseases which are of no consequence on native hosts. This possibility is exemplified by the high susceptibility to blister rust of our northern white pine (*Pinus strobus* Linn.) planted in western Europe, whereas several native European species of the white pines growing there are resistant to the rust.

THE RESPONSE TO FULL RELEASE OF WHITE PINE PLANTED UNDER JACK PINE[1]

By T. SCHANTZ HANSEN

University of Minnesota

ALTHOUGH isolated examples of the growth of plantations and their individual responses to some form of cultural treatment prove little, information gained adds to the total knowledge of the behavior of the species and serves as a basis for comparison with other studies. It is for this reason that the following rather limited data on the behavior of underplanted white pine to full release are presented.

In 1913 several white pine plantations were established on the Cloquet Forest. The stock used was purchased from commercial nurseries, and no information was obtainable as to its age. Its appearance at the time of planting gave the impression that it was either 3-0 or 4-0 stock.

One of these plantations, about five acres in area, was established under a stand of 37-year-old jack pine. The stand was a portion of the control strip for a thinning made in 1912. Normal yield tables subsequently constructed show that, by basal area, the original stand was 40 per cent understocked. This indicates a rather open, rapidly growing stand before thinning. The thinning, which removed 232 trees per acre, reduced the stand to 37 per cent of the normal number and 84 per cent of the normal basal area. It opened the stand and made excellent conditions for planting white pine under the open-crowned jack pine.

The site is average for jack pine in the Lake States, but slightly below average for Minnesota. The soil is classed as Omega loamy medium sand. This soil is one of the lightest found in the northeastern portion of the state, and is by no means white pine soil. At the time the plantation was established the prevailing idea was to replace jack pine stands with either Norway or white pine regardless of soil conditions. Certain portions of this soil type on the Cloquet Forest have in the past produced excellent white pine, but only where the water table was high enough to compensate for the lightness of the soil.

The ground cover consists largely of blueberry, wintergreen, sweet fern, trailing arbutus, and herbaceous vegetation common to this type. Underbrush was absent at the time of planting, and has not come in since.

The survival of the plantation was excellent; counts made at the end of the first growing season showed a survival of 96 per cent. The number of trees, 1,140 to 1,230 per acre, in the two plots of Table 1 indicate that this high survival was maintained. A 6 x 6 foot spacing was used, which would result in a stand of 1,210 trees per acre if the spacing had been rigidly adhered to. The good survival is no doubt the result of high precipitation during the growing season of 1913 rather than of care in planting, since the slit method was used and the planting was done at the rate of one acre per day per man. During the 1913 growing season the precipitation amounted to 17.82 inches, which is 4.09 inches above normal.

No treatment was given the plantation until the fall of 1924, when the overhead jack pine stand was removed from all

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TABLE 1

HEIGHT GROWTH OF RELEASED AND UNRELEASED WHITE PINE

Year	Released Avearge height Feet	Released Range of height Feet	Released Number of trees weeviled	Unreleased Average height Feet	Unreleased Range of height Feet	Unreleased Number of trees weeviled
1924	3.9	1.0- 9.4	43	3.8	0.9-10.2	38
1925	4.5	1.6-10.0	45	4.5	1.5-10.6	40
1935	13.6	6.0-20.2	62	10.7	5.1-17.4	15

but a small portion of the plantation left as a check. Two 1/10-acre plots, one in the released portion and one in the uncut stand, were established immediately following the cutting. The trees were measured for height to the nearest 1/10-foot. The plots were remeasured in 1925 and 1935. The results are given in Table 1.

The data in Table 1 show that the average height for the two plots was comparable in 1924, and that any difference in height growth during the first season following the release was in favor of the unreleased portion of the plantation. During the period 1925-1935 the average height of the released plot increased from 4.5 feet to 13.6 feet, whereas the unreleased portion increased from 4.5 feet to 10.7 feet. The release evidently stimulated the height growth by 50 per cent.

These figures do not tell the entire story, however, since considerable weevil injury was present. It was found to be much heavier on the open plot, which would tend to reduce the average height of the trees.

The white pine weevil, *Pissodes strobi* Peck, is not usually considered a serious pest in this region for two reasons. The first is probably that foresters fail to evaluate the damage properly. The second is the type of damage itself. It is seldom that forked or bushy trees result from weevil attack. The resulting damage is usually a slight offset in the stem, which disappears in a few years. Apparently trees are seldom attacked in successive years, which gives them a chance to develop new leaders.

At the time of release 43 trees in the released plot and 38 in the unreleased plot showed weevil injury, which amounted to about 30 per cent of the stand in each instance. The situation was little changed in 1925. In 1935, 62 trees, or 50 per cent of the released stand, showed definite weevil injury during the intervening ten years; 21 trees or approximately 16 per cent of the stand had been weeviled during 1935. In the unreleased stand only 15 trees, or about 8 per cent of the stand, showed weevil injury during the 10 years; 4 trees, or less than 3 per cent, were weeviled during 1935.

In order to determine when the released portion adjusted itself to take advantage of the improved growing conditions, the distance between whorls of branches of ten unweeviled trees on each plot was measured. The average dis-

TABLE 2

ANNUAL HEIGHT GROWTH OF RELEASED AND UNRELEASED WHITE PINE, BASED ON MEASUREMENT OF DISTANCE BETWEEN WHORLS

Year	Annual height growth—inches *Released*	Annual height growth—inches *Unreleased*
1925	7.2	7.4
1926	7.3	7.8
1927	12.4	7.4
1928	9.7	7.0
1929	8.1	8.1
1930	11.7	7.4
1931	16.8	10.4
1932	13.8	11.8
1933	13.7	9.9
1934	15.7	9.9
1935	19.5	17.9

tance between whorls is given in Table 2.

The released portion showed a definite increase in height growth over the unreleased portion in the third season following the removal of the overhead stand. For some unexplained reason the height growth was the same on both plots in 1929, otherwise the released portion exceeded the unreleased constantly after the second year.

The average annual height growth for the 10-year period 1925-1935 was 0.9 foot for the released portion and 0.6 foot for the unreleased. If weevil damage had not entered into the picture, the difference might have been greater.

No attempt has been made to prove the value of these figures statistically. The data are insufficient to establish any general conclusions. They are presented merely as the results of releasing a single plantation.

WARD SHEPARD, director of the Harvard Forest, has been appointed to membership on the faculty of the new Graduate School of Public Administration made possible by the recent gift of $2,000,000 by Lucius Littauer.

The rest of this academic year and all of next year will be devoted to exploratory conferences with groups of public officials and a limited number of advanced students drawn from the public services, to determine the scope, functions, and methods of the School. A building to house the School will be built in the near future.

It is expected that advanced instruction and research in the conservation of natural resources in the broadest sense will be an important element of the new School in collaboration with several other Departments of the University, including the Harvard Forest.

REGIONAL DISTRIBUTION OF INSTRUCTION IN PROFESSIONAL FORESTRY

By H. H. CHAPMAN

Chairman, Committee on Schools of Forestry

THERE is a strong tendency at present, because of the quickened interest in forestry, to provide for professional instruction in state institutions not previously giving such curricula. This arises from the pressure of students, as citizens of these states, to secure what they want at their state colleges tuition-free instead of being obliged to go elsewhere at greater costs for fees and travel.

The underlying fallacy of such a movement lies in the fact that, while education may be termed a responsibility of each state, the state assumes no such responsibility for employment of the men so trained; and public service is now employing over 70 per cent of all professional foresters. It is true that no institution bears the responsibility for employment of the graduates, but it cannot escape that of proper consideration of the actual needs of the profession, nor the relative efficiency of other institutions for fitting men for the chosen field. The modern tendency is to avoid duplications, to strengthen strong departments in some institutions and to discontinue competing weak departments in neighboring schools.

In three eastern states, two rival schools of forestry were established originally, for undergraduate instruction. In one of these states, the two were combined into one; and in another, one school was discontinued in favor of the second. Such eliminations are extremely painful, not always possible, and often give rise to charges of political manipulation. In one or two other instances, attempts at formulation of a new 4-year curriculum have been abandoned in concession to the existence of other and better-established departments in neighboring states.

The great majority of undergraduate students in forestry tend to seek an institution in their own state, or in the region in which they live. A more enterprising or better financed minority deliberately choose one in an entirely different region. This tendency becomes dominant for postgraduate instruction.

The effect of this pressure for new departments can best be studied by a sketch of the present regional distribution of schools of forestry.

Northeastern Region

This region, containing northern conifers in northern New England, New York, Pennsylvania, and West Virginia, is otherwise a hardwood region. It contains two graduate schools, one of which, Yale, accepts graduates prepared in science but with no forestry, the other, Harvard, conducts a research institution employing silviculture and management. Of accepted or accredited schools giving undergraduate (and graduate) instruction, it has the New York State College of Forestry at Syracuse University, with free tuition to state residents, and the Pennsylvania State College. In the second group, that of listed schools, is the Department of Forestry at the University of Maine, located in a state which contains the larger portion of the forest area of New England. Minor nonlisted departments teaching forestry for a professional degree are the University of New Hampshire and the Connecticut State College; the latter is now specializing in game management and is not developing the forestry curriculum. In Massachusetts State College instruction is closely confined to farm and elementary forestry.

In this region the University of West

Virginia, a state with a large forest area, has launched a program for the establishment of a professional 4-year course in forestry for local students, despite the availability of the above institutions with an enrollment in forestry of 1,310 in 1936-37, and of others in neighboring regions.

Lake States and Central Hardwood Region

In this region are found four accredited schools, namely, the University of Michigan, Michigan State College, the University of Minnesota, and Iowa State College; and one listed school, Purdue University, Indiana. Yet in Michigan, which has maintained two schools since the first decade of this century, the School of Mines at Houghton in the upper Peninsula recently inaugurated a 2-year preparatory course in forestry, but with no declared intention of extending it to 4 years. Ohio State, by recent decision of its Board of Regents, has limited its curriculum to the first two years. Wisconsin and Illinois have deliberately avoided the institution of professional training. Recently however, Missouri has installed a preparatory two-year curriculum in forestry. There is no instruction in Kentucky. The attendance at the five established schools in 1936-37 was 1,440.

Southern Region

Here we find the most crucial situation, due to the delay of twenty years in development of forestry practice, the large areas and great economic importance of forest land, and the relative lack of financial resources of institutions attempting to teach professional forestry.

There is no accredited school of forestry as yet in this great area, though three schools received listing, namely, those at the University of Georgia, the Louisiana State College, and the University of North Carolina. At Duke University, North Carolina, a privately endowed institution, a fourth school for undergraduates has been started, with fair prospects of adequate support.

The University of Florida, encouraged by a legislative grant of $25,000 for forestry instruction, now enters the field as a source for the professional degree, in competition with these other schools. Much thought and study have been put on the subject by other colleges in South Carolina, Alabama, Arkansas, Mississippi, and Tennessee, all of which have offered elementary courses in forestry in the first two academic years. So far, apparently, the temptation to enter the professional field has been resisted. The attendance at the three listed institutions in the year 1936-37 is 621, which to say the least should help supply the needs in this region, though compared with the land available and the prospects for forestry the number is proportionately much smaller than in the two northern regions.

Western Region

Here we find five accredited schools, in the state universities of California, Idaho, Montana, Oregon, and Washington. In Colorado is a listed school at the Agricultural College. Unlisted schools are maintained at Utah State College and at the State College at Pullman, Wash. In this region the only states without such curricula are New Mexico, Arizona, and Nevada, where no pressure seems to exist. The attendance in 1936-37 for all of these schools is 2,840, which, considering the almost total absence of state forestry and of private practice except in the West Coast states, is probably a greater overdevelopment than that found in the East, and reflects the effect of state public employment and a high standard of merit, in encouraging men to take up the profession.

Here the principle of a school for each state seems firmly grounded and will probably continue; and there is room for no more schools.

Prairie Region

In the states of North and South Dakota, Nebraska, Kansas, Oklahoma, and Texas no school exists offering professional for-

estry instruction, if we except the School of Forestry at Bottineau, N. Dak., which has courses in tree planting and windbreak forestry, and a 2-year course at South Dakota which threatens to expand into a 4-year curriculum. Oklahoma has been nibbling at the bait, and Nebraska once had an excellent small school which turned out men well trained along ecological lines. It is not probable that any of these states will qualify in the professional field.

The crucial problem thus seems to be in the South and the Central hardwood states. The advantage lies with existing established institutions, but this lead cannot be held unless the institutions supporting these pioneer schools find greater resources with which to build them up to a degree of excellence comparable with those of other regions, and capable of filling the needs of students from adjoining states.

THE EUROPEAN PINE SHOOT MOTH IN SWEDEN

By THADDEUS PARR

Yale School of Forestry

THE fact that there is a heavy infestation of *Rhyacionia buoliana* Schiff. in some extensive plantations of Scotch pine (*Pinus sylvestris* L.) in southern Sweden had been known to Professor Trägårdh at the Royal Swedish Forest Experiment Station for some time. It was the writer's privilege in 1935 to take part in the preliminary investigations carried out in Blekinge, and later to assist Dr. Butovitsch in the compilation of the data, during the course of which some very interesting facts have come to light. It is thought that these will be of interest to American forest entomologists who may have occasion to work with the insect.

The history as well as the host plants of *R. buoliana* in Europe are well known to American forest entomologists (8). In the following brief discussion it does not seem necessary to elucidate these two subjects further.

Biology

When the various plantations were investigated in the latter half of June, it was found that the insect was in the late larval or pupal stage. By June 28 all but a very few of the individuals had pupated. From 117 pupae gathered at that time, taken to Uppland, and held in rearing cages for the collection of parasites, the first adults emerged on July 9; and emergence continued until July 21. Only 27 adults were obtained, 9 males and 18 females. Sixty-seven of the pupae which were neither parasitized nor diseased had failed to produce adults. These had apparently been held under conditions that were too dry and warm to allow adult emergence. Some of the pupae, when opened, disclosed the adults dead when apparently almost ready to emerge.

Copulation was observed on the evening of July 11. The first eggs were laid in the cages on July 12, oviposition taking place at night. The number of eggs laid per female was not determined, but it was not large, probably averaging not more than 15. Eggs were placed not only on the twigs, needles, and buds in the cages, but on the sides, top, or bottom as well, as has been noted by Friend and West (8).

The larvae in the field act exactly as described by DeGryse (3) and Friend and West (8). The greatest distance from the buds that larvae were found feeding on needles was 8 cm. (field observation). Most of the larvae were in the buds in September in Blekinge. This was also true for Uppland, and it is suspected that it will hold for Norrland as well. As both DeGryse (3) and Friend and West (8) point out, one larva may eat more than one cluster of needles before migration to the buds. This was clearly shown in sample plots taken by Dr. Butovitsch in Blekinge early in September. It was also ascertained at that time that one larva may eat as many as two or sometimes three buds before becoming dormant, although the usual number for a single larva to eat is only one. Much depends upon the size of the buds. The length of the hibernating larvae ranges from 4 to 5 mm.

According to Bodenheimer (1), *R. buoliana* requires 3,600 day-degrees C. of effective temperature to produce one

generation. In Blekinge there are, on the average, but 2,854 effective day-degrees C. during the year. Nevertheless, *R. buoliana* produces one generation every year, as it does in Uppland also, where there is an average of 2,470 effective day-degrees per year. Although exact data on the biology of the insect in Norrland are not available at present, the insect has been reported from there, and the Swedish forest entomologists and the writer are of the opinion that it has one generation per year there also.

According to the work of West (13) in Connecticut, the minimum lethal temperature for *R. buoliana* is —18° F. Since the insect has been reported from Norrland, where there are very low winter temperatures, it would seem that it must be able to adapt itself to such conditions and survive.

Relations to Host Trees

It was apparent from the data obtained from the sample plots investigated in Blekinge that the site quality did not materially affect the infestations. Trees on the better sites were as susceptible to attack as those on the poorer. The trees on the poorer sites, however, may be more seriously injured than those on the good sites because they are generally smaller and more slowly growing, requiring longer for the plantation to close.

It was definitely shown that close plantations were more free from larvae, not only in the percentage of buds infested but also in actual numbers of larvae present. Plantations where the trees were planted close together (1.1 x 1.1 meters), or where the trees were planted two in each hole, actually had from one-half to two-thirds fewer larvae per 100 square meters than the plantations where the trees were scattered and planted singly. The Russian forest entomologist Zhicharew (14) has also observed that naturally regenerating pine is more severely damaged than planted pine because the trees are in small groups or scattered singly in the natural regeneration.

Most investigators have stated that the taller trees are less susceptible to attack than the shorter ones, giving the impression that the insect actually prefers the shorter trees or cannot fly to the tops of the taller ones. Investigations in Sweden seem to indicate that not the height of the tree but the size and number of the buds and the size of the shoots make it practically physically impossible for *R. buoliana* to survive in the older trees. In an investigation of mature trees (about 100 years old) at Experimentalfältet on March 23, 1936, it was found that the buds in the top of the trees average but 3.4 mm. in length and that 92 per cent of the clusters had but one bud. Further investigations revealed that the 1935 shoots averaged 2.035 mm. in diameter outside the bark. Measurements of fully grown larvae gave an average of slightly over three mm. at the largest diameter. Since the inside of the gallery must necessarily be slightly larger than the larva, in the old trees it would be physically impossible for *R. buoliana* to feed on the buds and shoots unless the feeding took place on the outside of the buds and shoots in the late larval stages. Figure 1 shows a gallery of *R. buoliana* in a spring shoot from a young tree, cut longitudinally, to compare the diameter of the gallery with the diameter of one of the largest shoots taken from the very top of a 100-year-old Scotch pine. It will be noted that the diameter of the gallery in the young pine shoot is larger than the outside diameter of the shoot from the old tree.

The age of the trees and the height at which this falling off of bud size and shoot diameter occurs in *Pinus sylvestris* in Sweden is not known at present, and it remains for further investigations to

show whether there is or is not a definite correlation between the age at which this occurs and a decrease in *R. buoliana* infestation.

Friend and West (8) state that the larvae feeding in the central bud of a cluster do so by chance. Investigations in Sweden on *Pinus sylvestris* substantiate this. If one considers that on Scotch pine there are generally five or six lateral buds at the tip of the terminal shoot for every central bud, then it must be evident that, unless the central bud is preferred, there are three possibilities for feeding after the insect leaves the first lateral. These are, one lateral on each side of the first, and the terminal bud in the center. Analysis of data demonstrated that almost exactly one-third of the larvae went to one side bud, one-third to the other side, and one-third to the central bud after the first lateral was destroyed. In the cases where the larvae mined a second lateral bud, almost half of them went next to the central bud and half to a third lateral. Feeding in the central bud is, then, purely a matter of chance. The data were obtained from analysis of the leaders from 149 eleven-year-old trees.

Fig. 1.—1935 shoot and bud from 100-year-old Scotch pine (left), and gallery of *R. buoliana* in a 1935 shoot from a young pine (right). Natural size. Photo by Statens Skogsförsöksanstalt.

Parasites and Predators

Various investigators have observed many parasites and a number of predators on *R. buoliana*. Only one attempt was made to determine the parasite population on the insect in Sweden during 1935. As stated above, 117 pupae were collected and placed in rearing cages. From these, 23 parasites emerged, indicating a 19 per cent parasitization of pupae. Of the parasites, no great variety were found. Twenty-one specimens were *Pimpla turionellae* L. (Ichn.) (identified by Dr. Roman), and two specimens were unidentified Chalcids. Coccinellid larvae fed upon the *R. buoliana* eggs in the cages, two specimens of *C. bipunctata* L. devouring most of the eggs on the top and door of one of the cages overnight. Ichneumonidae were observed ovipositing in larvae and pupae in the field. Birds account for some of the larvae, probably more in the early stages, when feeding is on and in the needles, than when the larvae are in the buds. Dr. Butovitsch also found the spider *Aranea atrica* C.L. living on the trees in Belkinge during September. Larval skins and head capsuls of *R. buoliana* were found in the webs.

Control

Swedish forest entomologists are convinced that direct control of *R. buoliana* would prove too expensive, especially if such work involved spraying operations or the removal and destruction of attacked shoots (8, 9, 11).

In Blekinge, one experiment with a German commercial preparation (Proherba) applied as a repellent was tried on young trees. It was applied as a spray late in June and an inspection of the trees in September showed part of them to be in poor condition. The younger trees (five years old) that had received less of the material were not seriously

injured, but the older trees (11 years) that had received more of the spray were decidedly affected. The sprayed branches and tops had dropped or were dropping their needles and were dying. Also, the material had not prevented oviposition by *R. buoliana* in the sprayed tops.

During the summer of 1936, an attempt will be made to control the insect, in the leading shoots only, by application of a sticky substance similar to Tanglefoot. This means, since the material would be applied only to the leaders, that the trees would have to be gone over every year for several years. However, the preparation is cheap and easily and rapidly applied. Cutting of the infested leaders would no doubt be effective, but Scotch pine does not seem to recover nearly as rapidly as red pine does in the United States, and the laterals which assume leadership cause serious crooks in the main stem of the tree.

Control by natural means is, of course, to be preferred. From the work done to date it seems that close planting will be the most effective in this category. It would seem that if the trees were set out 80 x 80 cm., and the leading shoots painted with the sticky substance (providing that material is effective) from, say, the fourth to the eighth years, then there would be little damage done in a plantation. By the time the application of the glue mixture was stopped the stand would be closed and there would be little further damage from the insect.

With still closer planting, rows 1.3 meters apart and the plants 50 cm. apart in the rows, as is frequently done in Germany, the application of the glue to the tops might be dispensed with entirely, for with closer planting infestation falls off; and although some plants might be attacked, there would still be enough left, free from injury, to form a fully stocked stand at maturity. In Sweden this would mean 400-500 trees per hectare on medium sites.

A complete account of the work on *Rhyacionia buoliana* Schiff. in Sweden to date is now being published by Dr. Butovitsch in the Meddelanden Från Statens Skogsförsöksanstalt.

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SEASONING TRANSVERSE TREE SECTIONS WITHOUT CHECKING

By R. C. RIETZ

Forest Products Laboratory

THE seasoning of transverse sections of trees without the development of checks extending from the bark to the pith has always been a problem confronting exhibitors wishing to show a tree section as it was in the green state, and to wood novelty manufacturers using whole tree sections in the production of various wood items. The reason a transverse tree section can be expected to check or split during seasoning is that the tangential shrinkage is greater than the radial shrinkage. This condition occurs in both hardwoods and softwoods. The extent of splitting to be expected in drying transverse sections is generally proportional to the ratio of the tangential to the radial shrinkage. This ratio is greater than unity for all common species of hardwoods and softwoods grown in the United States.

With the development of chemical seasoning methods, the Forest Products Laboratory has found that some woods can be stretched and "set" in the tangential direction sufficiently to bring the shrinkage ratio near unity. Under such conditions the liability of checking or splitting during the seasoning is greatly reduced. Chemical seasoning consists of impregnating green wood with hygroscopic salts or other hygroscopic substances by a diffusion process, and then either kiln-drying or air-drying the treated material. The diffusion of the hygroscopic substance is usually arrested while a concentration gradient of the hygroscopic substance exists in the wood.

Sodium chloride, or common household salt, has been much used in chemical seasoning experiments at the Forest Products Laboratory because of its cheapness and excellent hygroscopic qualities. If common salt is allowed to diffuse into wood that is subsequently dried at a relative humidity maintained near 75 per cent, the salt-treated surface areas of the wood will not dry and shrink, yet the untreated interior green portions of the treated wood will dry in response to the lower relative humidity effective at the wood surfaces. The salt-treated wood retains its water at 75 per cent relative humidity and does not shrink, yielding a method whereby the interior untreated portions can be dried and stressed by the unshrunken exterior.

These stresses enable the setting of the untreated interior material; and when the exterior treated portions are finally dehydrated or dried by subjection to lower relative humidities, the interior set portion allows the stressing of the exterior, finally setting the whole specimen in an expanded condition. In other words, chemical seasoning with hygroscopic salts offers a method of literally shrinking wood from the inside out. This chemical process is applicable to the seasoning of tree sections, and, although only sections of yellow birch have been experimented with at the present time, it is believed that the application of the principle to other species is worthy of consideration.

A yellow birch section one inch long the grain was cut from a tree about two feet in diameter and soaked in a saturated solution of common household salt for four days. This salt-treated section was then dried by subjecting it to an initial relative humidity of about 65 per cent at 80° F. After about two months of drying at this condition it was subjected to a relative humidity of about 30 per cent for an additional two months and finally

allowed to stand in a heated office during a winter heating season. After the salt-treated section had been in a 30 per cent relative humidity for some time, it was finished; but further drying of the section while standing in the heated office caused the movement of salt through the finished coating, and refinishing was necessary.

Figure 1 shows the present finished condition of the seasoned birch section. In drying a section after the salt treatment, the salt tends to come to the end surfaces, but it is easily scraped and sanded off at the time the end surfaces are being prepared for finishing. This particular section was finished, after being planed

Fig. 1.—Section of yellow birch approximately two feet in diameter and one inch thick, salt-treated and seasoned without checking or splitting.

and sanded to a fine surface, by first applying linseed oil and turpentine mixed half-and-half to bring out color contrasts, after which three coats of shellac were applied, with each coat rubbed down before the final varnish coat was brushed on.

To those interested in experimenting with the use of hygroscopic chemical treatments in the seasonings of tree disks, the following precautions are suggested:

1. The disks must be absolutely green at the time they are treated in the salt solution. If end checking has already started, the treatment is of little value in controlling the checking and splitting in subsequent drying.

2. The sections or disks should be flat and fairly smooth before the chemical treatment is made, in order that in finishing after the specimen has been finally seasoned the salt-treated area is not removed.

3. A treatment in a saturated salt solution for from four days to one week is usually sufficient, although the thicker the disk the longer the treating period should be. Time in the treating solution also depends upon the species; and if the disks are mostly heartwood the treating period must be prolonged. These treatments can be made at room temperatures. The salt solution should be stirred occasionally.

4. The specimens or disks after having been salt treated should be dried gradually, starting with a relative humidity not much less than 65 per cent. At room temperatures ample time should be allowed for seasoning at the various stages.

5. The disks should be dried to an equilibrium condition a trifle less than would be found in use, if possible, in order to prevent bleeding of the salt after the specimens have been smoothed down and finished.

If the experimenter does not have equipment whereby relative humidities can be controlled, it is possible that cool cellars or other rooms in which atmospheres are at higher relative humidities can be used for the initial drying process. If the relative humidity is too high, the salt will dehydrate the air and the specimen will literally sweat, causing a leaching of the salt, which is not desirable.

"EINZELSTAMMWIRTSCHAFT" OR MANAGEMENT OF THE INDIVIDUAL TREE

By T. SCHANTZ HANSEN

University of Minnesota

DURING the past year or two the question of "Einzelstammwirtschaft" has found a prominent place in German silvicultural literature. The question is a timely one not only to the German forester, but to American foresters as well.

We are apparently standing at the beginning of an era of wider application of silvicultural methods to public and private forests. This wider application will without a doubt bring forth new proposals and departures, so-called, from the old standard methods. We find the question of "selective logging" prominent in our own literature. The discussion which it provokes proves that there is not complete agreement as to its value and universal application. The ultimate proof of the value of this or any other silvicultural procedure lies in its application to actual stands. This involves a relatively long period of waiting. Much can be learned from experiences elsewhere.

The present article is based on a discussion at the meeting of the Deutscher Forstverein at Bonn in 1934, and upon several articles appearing in various technical publications. A description of the "Einzelstammwirtschaft" method will be given first, followed by the advantages claimed by the proponents, after which the opinions of dissenting foresters will be set forth.

There seems to be a general agreement among German foresters that the yield from the present-day German forests is not satisfactory. The returns on the investment do not measure up to other forms of national endeavor. Because of the low return it is becoming increasingly difficult to secure adequate public funds for investment in forests, and private capital is seeking fields where the return will be greater. It is the feeling of many German foresters that the silvicultural methods which have been used in the past are responsible for this condition. "Einzelstammwirtschaft" is recommended as a means for increasing not only the yield but also the quality of the product, thereby increasing the financial return.

"Einzelstammwirtschaft" is, as the name implies, management of the individual tree. It is quite closely related in character with "Dauerwaldwirtschaft". Once again the age-old conflict between even- and uneven-aged stands, between clear-cutting methods and selection systems, takes on new life. It seems somewhat difficult to distinguish "Einzelstammwirtschaft" from the selection system. Hawley (3) defines the selection system as follows: "According to the principle of the selection method, the oldest or largest trees in a stand are harvested. After one or more years another cutting of the same character is made. . . ." Einzelstammwirtschaft considers the individual tree, tries to provide the best growing conditions for it, and harvests it at the time when physical maturity has been reached. No attempt is made to clear-cut the area; cuttings are more or less of an annual affair, as circumstances may warrant. Under this system no attempt is made to secure reproduction during any definite period. The reproduction of the stand is a result, not an aim, in this instance.

The fear of producing limby, low-grade material and bringing about soil deterioration has made the German for-

ester keep his stand closed. The advocates of "Einzelstammpflege" claim that the closed even-aged stand has not produced clear material, nor has it benefited the soil, as is shown by the yield of the German forests. It is felt that a return to natural conditions or to the virgin type of forest will increase the quality and quantity of material produced.

There are two viewpoints from which this problem can be discussed. There is, first, the viewpoint of forest management. Any change from clear-cutting or partial-cutting systems will necessitate changes in methods of keeping the records and in forest inventory methods. In this discussion questions involving management and growth studies will be omitted. The second viewpoint is that of silviculture. Such questions as rate of growth, quality of material, and reproduction of the stand under the single tree system will be discussed.

Volume Production

As has been previously said, there seems to be a general agreement on the part of German foresters that the volume production of the German forests is not satisfactory. Differences of opinion become evident when a solution of this problem is dicussed. Ortegel (2) believes that the solution can be found in the production of uneven-aged stands of the virgin type as developed under single stem management. Since no growth figures are available to substantiate his claim, he compares a diameter-growth study made in virgin spruce with a study from an even-aged spruce high forest. By means of these curves he shows the rapid growth in the younger even-aged stand, followed by a slowing up as the stand becomes older. The reverse is true in the case of the virgin stand. The period of suppression which lasted during the first hundred years did not have a detrimental effect upon the subsequent growth of the tree when released. Since the more rapid growth was laid on when the tree was larger and older, a more favorable return can be expected. The younger age classes are in a minority in the stand. This fact, coupled with the more rapid growth on the older and larger trees, leads to an increased total yield.

Quality of the Product

By delaying the period of rapid growth until the tree has attained a considerable size, a larger proportion of good saw timber is produced. The shading of the tree during youth and its subsequent release produced a more uniform wood structure, at least in the lower portions of the stem. Self-pruning in a stand under "Einzelstammpflege" begins while the tree is young, and consequently extends to the heart of the tree. Lateral branches are smaller than in even-aged stands, and because of the slower rate of growth a smaller proportion of the dead stub is incorporated in the trunk before it falls through natural causes.

Reproduction

The regeneration of the stand comes about as a result of the system, and is not an aim in itself. Planting is not precluded, especially when it is desirable to control the composition of the stand. Since overhead shade is used to develop clearness, it is not necessary that the reproduction be as dense as in the case of even-aged stands.

Even in the case of intolerant species, such as pine and oak, Ortegel feels that the system is workable. He does not agree with other German foresters that the renewal of these stands depends upon some catastrophe, such as storm and fire, that lays waste a relatively large area. He points out that pine and oak were important species in the forest of eastern Ger-

many. It has been proven that storm damage is insignificant there, and that fires were a rare occurrence even in prehistoric times. He contends that the intolerant species do not produce such a heavy shade, but that reproduction of their own kind can come in as "shade forms" of that species.

Application to Present Stands

The system is applicable to even-aged stands of the present day by careful selection of the most promising trees, either in groups or as individuals. By judicious thinning the period of rapid growth of these promising individuals can be lengthened and the conversion to an uneven-aged stand can be brought about gradually.

Even in the case of defective stands, the same principles can be applied with beneficial results.

Ortegel believes that much of the advantage in growth rate for the uneven-aged stand is due to the fact that crown friction is entirely eliminated.

That the system inevitably leads to a mixed stand is a foregone conclusion. It is, in fact, one of the aims of the system. The mixture must, however, be controlled. As an understory in intolerant species, birch and oak are recommended. A continuous understory is to be avoided. A continuous canopy is to be avoided in all stages and ages.

This, in brief, is the description of the system and the advantages of it as given by Ortegel. It is his conception that the compartment system of management should be abandoned. No clear cutting should be done in any type of stand. According to his idea, Einzelstammwirtschaft has universal application to all types of stands. It is acknowledged that this will necessitate smaller forest units, more frequent estimates and revision of management plans, and the employment of more personnel, both technical and nontechnical.

That all German foresters are not in complete agreement as to the universality of the system is shown by the discussion at the Bonn meeting. Nevertheless, there is agreement that the system has merit when applied to certain stands and certain types.

President Rau (2) of Stuttgart contends that selection forests do not necessarily produce more than even-aged stands. In support of his contention he cites coniferous districts in Wurtemberg, where the stands are all even-aged, and are producing 10 cubic meters per hectar per year, an amount in excess of the production of the Swiss selection forests. He believes that intolerant species will be eliminated. It is not definitely proven that selection stands produce clearer or a more uniform quality of wood. The period of suppression, lasting from 50 to 100 years, followed by release may, and often does, produce shake in the tree when the accelerated growth begins.

Professor Baader (2) of Giessen does not believe that the total yield can be increased under this system. He cites a thinning experiment in Hesse where the effect of a grade A, B, and C thinning was followed through a period of 45 years. When the total yield was considered, the various degrees of thinning produced the same amount of material; but when the value of the product was considered, the C grade thinning was far ahead of the others. From this he concludes that a given site has a certain productivity which can not be altered by thinnings or other silvicultural methods, but that the value of the product can be influenced. He believes that selection forests, which result of necessity from Einzelstammwirtschaft, should have a prominent place in German forests, but should not be the universal rule. It should be applied in the forests managed under coppice with standards, in stands

found on limestone formations, and in all protective forests.

One of the chief dissenters is Professor Dengler, Editor of the Zeitschrift für Forst und Jagdwesen (1). He sees nothing new in the proposal save that it is now being advocated universally.

He believes that even-aged stands can be managed so that a constant width of annual rings can be produced. If they are not, it is the fault of the management, not the system. The upper portions of the trees used by Ortegel for his curves show the same characteristics of growth as do the even-aged stands. He believes that the period of suppression is damaging.

Einzelstammwirtschaft depends on producing natural reproduction without giving it enough light or without opening the forest enough to allow artificial regeneration, should the natural fail. In either case a two-storied forest results where in all probability compartment management must eventually be practiced.

The system produces openings in the canopy which will never close in the case of pine stands. He cites the example of 150-year-old stands where the crowns increase only 2 meters in diameter in 60 years. These openings will lead to problems not equalled by any catastrophe. Nature works slowly in virgin stands, and man does not have time to await the results.

He believes that the system is applicable to spruce stands and mixed stands.

Wendroth (4) believes in using the natural forces when possible. Much of the confusion that exists over the application of the method is due to a faulty understanding of site. On certain sites the system will work. The border-line cases are, however, difficult to determine.

Witzgall (5) believes that Einzelstammwirtschaft is not the same as the free growing of individuals. He believes that the "static power" (protection from wind) is one of the most important functions of the old stand. This function has been largely overlooked, especially in the case of even-aged stands. The utilization of this feature in silviculture has an important influence upon the growth rate and form of the tree. He recommends the leaving of wolf trees and their pruning for the protective value.

This, then, in brief is the newly advocated "Einzelstammwirtschaft". Actually, there is nothing new in the system. It is simply a very intensive form of the selection system. It is a system that can be applied only where the practice of intensive forestry is possible. It differs from our own selective logging in that the trees selected for final harvest are selected from the standpoint of their physical maturity and their position in the forest, not from the standpoint of their merchantability. It is true that trees selected are without a doubt the best merchantable trees, but at the same time others not quite fully mature but equally merchantable are left.

The proponents of the system in Germany argue that it can be successfully applied to all types of stands. As has been shown above, other German foresters believe that the system has merit but can be applied only in certain stands. In this country it might be successful in stands where the selection system would work. In the coniferous stands of the Lake states there would be grave danger of having hazel and alder brush take over the area under the gradual opening of the stand under this system. In jack pine it is extremely doubtful that the system would be successful even though brush did not come in. Jack pine is extremely intolerant and, at least on the medium and poor sites, shows very little ability to recover from suppression.

"Einzelstammwirtschaft" does, however, hold something of promise for us in this

country. It typifies the trend in German thought, where the emphasis is placed on the needs of individual trees rather than on the stand as a unit. This is noticeable in their present-day literature on thinning as well. There is a tendency to break away from arbitrary rules in all silvicultural practice and to leave much to the initiative and judgment of the individual forester. Where intensive silviculture is possible in this country, we might well profit by giving the practising forester a chance to exercise his judgment, presupposing, of course, that an adequate and competent personnel is available.

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A NEW MAP COLORING PROCESS

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MAPS unquestionably constitute an essential tool of the forester. If they are properly made, the facts that they portray are readily seen and understood. Several different methods of preparation are available, included among which is the use of colors, either alone or in combination with other devices. Well-chosen colors, neatly applied, are capable of converting complicated maps into pictures that are simple, impressive, and of pleasing appearance. The attainment of these objectives, however, brings up the problem of a suitable color process.

Up to the present time much of the work of the California Forest and Range Experiment Station forest survey staff[2] has involved the production of maps, many of which have been colored. Several different techniques have been used, involving such mediums as crayons, dyes, water colors, and ink washes. Although each possessed some advantages and may have been the best available for certain purposes, none filled the desire for a general, all-purpose office color process. Difficult or laborious application, fading, opaqueness, unsatisfactory appearance, and limited possibilities were some of the obstacles attending their use. In addition, at least as far as the tests were carried out, none could be successfully used in the preparation of transparencies on vellum or tracing cloth, for which a need existed.

Recently, workers in the local Resettlement Administration drafting office found it possible to produce colored maps of sufficient transparency for light table work by using printer's or lithographer's inks on paper that had previously been impregnated with castor oil. The vehicle in which the pigments were suspended to form these inks, however, consisted of an oil which made subsequent lettering or writing on the colored surfaces with drawing ink difficult. In combination with the castor oil it also produced a sticky surface quite difficult to keep clean unless treated with some protective coating such as lacquer. Color dilutions were obtained by the addition of white, which resulted in opaqueness and a mottled finish.

Further exploration of this idea in cooperation with the chemist of the California Ink Company (Berkeley) has now led to the development of a new vehicle, called "Transparent Base"[3], which has corrected the features hitherto objectionable while retaining all of the desirable qualities. This vehicle plays the dual roles of suspending fluid and diluting agent. It is insoluble in water but soluble in amyl acetate. When exposed to free air it evaporates rapidly. It is non-oily, yet does not wet the surface to which it is applied. True to its name when spread in a thin film, it transmits light readily. The colored inks are merely suspensions of insoluble pigments in this "Transparent Base."

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[1]The writers are indebted to R. C. Sherman, chemist of the California Ink Company, for the development of the new vehicle used in this process and for other technical assistance. Grateful acknowledgment is also made for the assistance given by G. F. Burks of the California Forest and Range Experiment Station.

[2]Wieslander, A. E. First steps of the forest survey in California. Jour. For. 33:877-884. 1935.

[3]Trade name of the California Ink Company.

This new process is being described with the thought that it will be found useful to others interested in map coloring. Its qualities and the technique involved are as follows:

Flexibility in Use.—The inks have been used successfully on many different types of paper. All the various grades of drafting and bond paper, and even the refractory glazed photostat paper, are readily colored. Vellum and tracing cloth, which are so sensitive to moisture that they cannot be colored by the ordinary methods, yield to this process and produce excellent colored transparencies.

After coloring, the maps may be stored in any convenient manner, subject only to the limitations of the paper. Whether it is folded, rolled, or flat, the colors retain their original appearance for an indefinite period.

Easy Application.—Application is simple and requires very little training to produce high-quality work, even by one with no previous coloring experience. The technique merely consists in spreading the ink with a brush over the surface to be colored, and removing the excess before it becomes dry with an artist's stump or cotton-tipped toothpick. Where the area on which a single color is to be used is large, only a portion is colored at a time before removing the excess ink. Adjacent portions are then merged into one another by rubbing with an artist's stump, without leaving any telltale lines.

Used alone, however, the ink possesses too much body to permit easy spreading and economical use. This is readily overcome by the addition of amyl acetate, which has no effect other than to make the ink more fluid, and is soon removed by evaporation. Only a small amount is required; excessive quantities result in too great a dilution and tend to produce a mottled effect. Addition of amyl acetate directly to the ink is unsatisfactory because of its rather rapid evaporation. The method followed in the survey work is to dip the brush in amyl acetate each time before dipping it in the ink. This practice is very simple and yet results in a desirable and constant fluidity.

Easy Removal.—Changes may be made and mistakes corrected as easily as the color is applied. Since the base is soluble in amyl acetate, application of the latter to a colored surface will dissolve the base and release the pigment. This is accomplished by rubbing the colored surface with a clean artist's stump or cotton-tipped toothpick that has been dipped in amyl acetate, repeating until all of the color is removed. The amount of amyl acetate required increases with the porosity of the surface. Following the removal of one color, any other may be applied in the same manner as the first.

Permanency.—In spite of their easy removal, however, the colors may be considered as being practically permanent for most purposes. Being insoluble in water, moisture has no effect upon them. When exposed to direct sunlight for a period of 30 days the undiluted colors have shown scarcely any sign of fading. Very dilute (5-10 per cent) mixtures faded slightly under similar exposures, but few maps are subjected to such conditions in ordinary practice.

Transparency.—The inks themselves are highly transparent to any printing or lines present on the surface prior to coloring. If opaqueness is desired, however, it may be obtained by the addition of white to the colored inks.

Paper that is already transparent, such as vellum, and tracing cloth lose none of their transparency when colored. Opaque paper that is not too heavy may be made quite transparent by impregnation with an oil. A number of different oils are available for this purpose, but many of them posses qualities that are undesirable for some types of work. Of the various oils tested a derivative of petroleum called

"Mineral Seal"[4] was found to be a very satisfactory medium for the production of transparencies. Its application is simple, and may be done either before or after coloring merely by rubbing the back surface of the paper with an oil-soaked cloth. Because of its low viscosity the oil penetrates the paper quickly and thoroughly. It is odorless and does not render the paper brittle. The oiled paper presents dry surfaces that will not readily pick up dirt or transmit the oil to other surfaces with which they come in contact. The oil will very slowly evaporate from the paper, finally leaving it in its original opaque condition, but further applications will restore transparency whenever this is desired.

Receptiveness to Drawing Ink.—No difficulties are encountered in lettering or writing on the colored surfaces, owing to the absence of any oil or oily substance in the prepared colors. This fact makes it unnecessary that all drafting work be on the maps before coloring. There is a slight tendency for drawing ink to "crawl" on paper that has been impregnated with "Mineral Seal," but this may be remedied through the use of drafting powder.

Flexibility in Preparation.—Any desired color may be readily obtained through the choice of pigments and the proportion of each used. The writers were able to produce 26 distinct colors from 6 pigments. Differences between colors may be accentuated whenever desired, by further additions of pigments. The degree of intensity or shade of any color may be altered at will by varying the amount of "Transparent Base" used. Provided equal amounts of the base are added, the differences between colors will be constant regardless of the degree of dilution.

Easy Duplication.—Provided the relative amounts of the various ingredients making up each prepared color are accurately measured and recorded, exact duplication is possible at any time. In the work done by the writers a sample of each color was placed on record, together with its formula and an assigned key number. A copy of this information was also deposited in the files of the ink company. Future duplications may be prepared either by the users or by the ink company, from which it will only be necessary to order by key number.

Pleasing Appearance.—The use of this process seems to open the door to easy production of colored maps unmarred by many of the blemishes that usually attend other methods. As previously stated, proficiency in application is attained with little experience. Work by different individuals does not vary perceptibly in intensity of color. A continuously smooth color surface is the rule rather than a mark of exceptional skill. The colors, whether intense or subdued, are clean and distinct.

Inexpensiveness.—Finally, the process is an inexpensive one. Small quantities of the materials go a long way in covering map surfaces. The inks, either in stock or specially prepared colors, and the "Transparent Base" cost little, considering their many excellent qualities. Other necessary materials are also purchasable at little expense. The labor charge, because of easy application, is a minimum.

[4]Trade name of the California Ink Company.

PLANTS EATEN BY CALIFORNIA MULE DEER ON THE LOS PADRES NATIONAL FOREST

By CYRIL S. ROBINSON

U. S. Forest Service

TO determine the value of forage plants for either domestic livestock or game animals some form of measuring stick must be used. The method employed by the U. S. Forest Service (1) in making grazing reconnaissance or surveys is believed to be best suited to a study of this kind. A survey of an area is made to determine chiefly the class of stock to which it is best suited, and the character, abundance, and value of the forage cover to the various classes of livestock. The value ratings or palatability of plants used by domestic livestock or deer as food is based upon the natural choice of the animals when grazing under normal conditions, and can be best expressed in numerals from 10 to 100.

The area chosen for this study was that portion of the Los Padres National Forest in San Luis Obispo, Santa Barbara, Ventura, Kern, and Los Angeles Counties. This area is within the range and distribution of the California mule deer (*Odocoileus hemionus* var. *californicus*) referred to by Cowan (1). The range in elevation is from near sea level to 8,000 feet. The forest area extends from the south coast ranges to Mt. Pinos and Mt. San Emigidio of the inner south coast range. The life zones are (a) the lower foothill and chaparral belt of the Upper Sonoran including the coastal area, and (b) the Transition Life-Zone.

It is the opinion of the author that deer are primarily browsing animals, and that the best yearlong deer range should be composed of approximately 60 per cent browse or shrubs, 25-30 per cent weeds and herbs, and 10-15 per cent grasses and grasslike plants. In the study made 1927-1931 (3, 4) this same composition in vegetative cover was suggested, and to date no change is recommended. It must be remembered, however, that any broad statement is but an expression of general conditions. Several instances of a 50 per cent utilization of grasses and grasslike plants and only 20 per cent of browse might be seen, but in estimating for yearlong use in this part of California, and planning for the management of deer over a very wide area with several types of cover, the foregoing percentage distribution is believed to be sound.

In determining the palatability rating of a plant used as forage by deer, it is essential that observations be made where natural grazing conditions prevail. Areas under heavy competitive use are to be avoided. In order to arrive at a conversion factor, useful as a basis for estimating rate of stocking on range grazed in common with domestic stock, a ratio of four deer to one cow, or 1.3 deer to one sheep, is suggested. The material for this paper, however, has been gathered almost entirely from areas used only by deer.

Many of the ratings have been worked out from recorded data kept on certain plants growing in a small "potrero" or grassland type far removed from any use by domestic animals. This spot, with the fringe of surrounding brush, has been a wonderful proving ground and is an excellent place for observation of feeding and other life habits of the California mule deer.

The distribution of deer on the Los Padres National Forest is governed largely by the corresponding distribution

of plants having good value as forage. Dense thickets of chamise (*Adenostoma fasciculatum*) and manzanita (*Arctostaphylos* spp.), usually the result of repeated burning, have little to offer as food, though the edges of these large brush fields show moderate utilization. The construction of well spaced openings similar to firebreaks through such areas is strongly recommended as an important means of obtaining wider allotment. This activity and the development of watering places should be in every wildlife management plan for this type of country.

The extent to which a plant is eaten varies with the season of the year, and such seasonal differences, when known, are noted on the plant list. Twigs as well as leaves are stripped from branches by deer in sidewise jerky motions of the head, but excessive use of the woody portions may often indicate a scarcity of feed.

The list of plants has been compiled from notes taken during the period 1932-1935, and cover every month in the year. Economic notations have been included for many plants to give information regarding the parts eaten and the season of year when heaviest utilization may be expected. My own recorded observations have been checked by opinions gathered from forest officers, stockmen, and interested ranchers. The botanical nomenclature used is from Jepson's "A Manual of the Flowering Plants of California" (2), and the common names are from the same source or local usage as shown by quotation marks.

Appreciative acknowledgment is hereby made to Aldo Leopold, professor of Game Management, University of Wisconsin, for his helpful advice and aid in reviewing the manuscript for publication, and to W. A. Dayton, senior forest ecologist, range forage investigations, U. S. Forest Service, for suggestions in arrangement.

Plant List

TREES, SHRUBS, AND WOODY VINES

10 *Abies concolor*. White fir. New growth only.

20 *Acer macrophyllum*. Big-leaf maple.

20 *A. negundo* var. *californicum*. California elder. Dried leafage also.

10 *Adenostoma fasciculatum*. Chamise. The dominant brush of southern California. In dense stands it has mainly cover value. The edges of these stands and isolated brush, however, show fairly constant use in spring and late winter. Fire-breaks and roadside activities have made lanes through hitherto closed areas, and the new growth from old roots is well eaten. Utilization, however, may be governed primarily by the abundance of other forage available, and by accessibility. The extent of chamise types on winter range is an important factor to be recognized in the management of all foothill areas.

20 *A. sparsifolium*. Red shanks.

40 *Aesculus californica*. California buckeye. Fair utilization everywhere of new growth, dried leafage, and fruit.

50 *Amelanchier alnifolia*. Western service berry.

10 *Alnus rhombifolia*. White alder.

10 *A. rubra*. Red alder. Both alders afford spring grazing, and the use of dried leafage in early fall has been noticed.

10 *Arbutus menziesii*. Madrone.

20 *Arctosaphylos patula*. Green manzanita.

10 *A. glauca.* Great-berried manzanita. The utilization in general is fairly uniform on isolated bushes and where other forage is scarce. Primarily a late fall-winter feed. Occasionally eaten closely in timbered areas, and may be of higher value wherever roads etc., give accessibility to fresh growth.

10 *Artemisia tridentata.* Common sagebrush. Sagebrush appears to be what cattlemen call "filler feed" and its use is almost entirely in winter. Its wide distribution and abundance constitute the main reason for value.

10 *Atriplex breweri.* "Salt sage". A coastal species.

30 *A. confertifolia.* Sheep-fat, spiny saltbush. A desert species and extensively utilized during winter. The dried leaves are also eagerly eaten.

20 *A. semibaccata.* Australian saltbush. This species is well eaten whenever the plants are found back from the sea coast. Experimental plantings on coastal fire-breaks have been damaged extensively by deer in the foothills of Santa Barbara.

10 *Baccharis pilularis.* Chaparral broom, coyote brush.

10 *B. viminea.* Mule fat.
Both species used occasionally in winter.

30 *Ceanothus cordulatus.* White thorn, snow brush.

30 *C. crassifolius.* "Mountain olive". A lowland shrub, fairly well eaten throughout the year.

10 *C. cuneatus.* Buckbrush. This species is valuable for its abundance and wide range. Used mostly in winter and spring. Mature shrubs have considerable importance, and isolated bushes and new sprouts are repeatedly cropped yearlong, but large areas or dense thickets may be considered as of relatively low value for feed.

40 *C. divaricatus.* Ceanothus.

60 *C. integerrimus.* Deer brush, "Sweet birch".

10 *C. macrocarpus.*

20 *C. oliganthus.*

20 *C. spinosus.* Red heart, spiny myrtle. Dried leaves, also in winter. The genus Ceanothus contains the greatest number of browse species having high value as forage. Their wide range throughout the state and their ability to withstand climatic extremes make them of great importance yearlong.

60 *Cercocarpus betuloides.* Hard tack, mountain mahogany. Excellent forage, the dried leaves also eaten. An important member of the chaparral group.

20 *C. ledifolius.* Desert mahogany.

10-20 *Chrysothamnus nauseosus* (varieties). Rabbit brush, yellow brush. Used in early spring and also on winter range.

20 *Cornus glabrata.* Dogwood.

20 *Dendromecon rigida.* Bush poppy. Quite common in burns along coastal range. Used in both spring and fall.

20 *Eurotia lanata.* Winter fat. Winter feed almost entirely.

40 *Ephedra californica.* Mormon tea, California tea. Eaten closely in winter.

40 *Fraxinus dipetala.* Foothill ash. Used in summer and fall.

40 *Fremontia californica.* Slippery elm, flannel bush. Eaten in spring.

20 *Garrya fremontii.* Bear bush, quinine bush.

30 *Holodiscus discolor.* Cream bush.

30 *Juglans californica.* Southern California black walnut. Green and dried leaves.

10 *Juniperus californica.* California juniper. The tips of branches eaten. Winter use mostly.

10 *Libocedrus decurrens.* Incense cedar.

30 *Lonicera interrupta.* Chaparral honeysuckle.

20 *L. subspicata.* Moronel. The leaves of both species eaten mostly in fall, but berries untouched.

20 *Photinia arbutifolia.* Christmas berry, Toyon berry. Spring and fall use.

50 *Pickeringia montana.* Pea chaparral.

10-20 *Pinus* spp. The cropping of all pine seedlings varies; excessive use may be indicative of scarcity of more palatable species. Pinon pine (*Pinus monophylla*) is occasionally browsed and the nuts are sought for in winter.

20 *Platanus racemosa.* Western sycamore. While among some of the earliest green feeds, the use of dried leaves is important.

20-30 *Pluchea sericea.* Arrow weed, mock willow. A plant of consequence in river bottoms and arroyos, eaten during fall and winter.

20 *Populus fremontii,* and *P. trichocarpa.* Cottonwood.

50 *Prunus emarginata.* Bitter cherry. An excellent forage shrub of the high country. Mostly fall use.

40 *P. ilicifolia.* Islay, island cherry. Important in the chaparral belt near the coast. Use of tender twigs and leafage, summer.

70 *Purshia glandulosa.* Bitter brush. Rare, and eagerly sought after yearlong.

10 *Quercus agrifolia.* Coast live oak.

20 *Q. chysolepis.* Canyon live oak, maul oak.

20 *Q. douglasii.* Blue oak.

20 *Q. dumosa.* Scrub oak. While not the most palatable, the leaves and fruit of this species are of great importance for forage on account of its wide range and abundance. Dense thickets, however, should not be rated as high as small patches or scattered growth.

20 *Q. engelmannii.* Mesa oak.

30 *Q. kelloggii.* California black oak.

10 *Q. wislizenii.* Interior live oak.

The leafage and twigs of all oaks, though extensively used, are not especially preferred when mature; the dried leaves are, however, a valuable addition to winter forage, and the fresh growth is well eaten wherever found. The greatest value perhaps lies in the mast or acorn crop, which is a staple food in late fall.

40 *Rhamnus californica.* Coffee berry.

70 *R. crocea.* Red berry. An excellent browse, closely eaten yearlong wherever found.

10 *Rhus diversiloba.* Poison oak. Use of mature leafage is not uniform, but new sprouts on burns are fairly well eaten. Has some value in spring.

20 *R. integrifolia.* Lemonade berry.

10 *R. laurina.* Laurel, sumac.

10 *R. ovata.* Sugar bush. Both this shrub and *R. laurina* show only the new growth as being cropped. Sprouts from cut shrubs on roadsides are well eaten.

20 *Ribes cereum.* Flowering currant.

10 *R. malvaceum* var.

20 *R. speciosum.* Spiny gooseberry.

All of the Ribes show utilization in fall, but rarely in summer. Leaves and fruit fairly well taken after frosts.

10 *Rosa californica.* Wild rose.

— *Salix* spp. Willow. The willows found in the Los Padres may be given a rating of 30. Utilization is usually in the fall, and seems to be fairly uniform, especially in years of high or normal precipitation.

80 *Sambucus glauca.* Blue elderberry. All parts, even the branches, closely eaten in late summer and fall.

30 *Symphoricarpos albus.* Snowberry.

30 *S. rotundifolius.* Snowberry, waxberry. A wide difference in amount of use of these two shrubs during summer.

30 *Vaccinium evatum.* California huckleberry.

RANGE WEEDS AND NONGRASSLIKE HERBS

20 *Achillea lanulosa.* Yarrow.

30 *Agoseris* spp. Mountain dandelion.

10 *Amsinka douglasiana.* Fiddleneck, buckthorn weed. This annual has increased to such an extent that it is considered a pest in many places. Forming dense thickets, it has invaded worn-out grain fields, and is very common on abandoned homesteads of the Cuyama River country. Scattered green plants receive attention by deer, but its major usefulness is in providing a "filler-feed" when dry. This herb may prove to be of importance in years of great forage scarcity in late fall and winter, both for deer and for domestic stock.

20 *Astragalus douglasii.* Loco-weed, rattle weed. Several others have been noted; use is mainly in fall and the leaves only are eaten, pods untouched.

30 *Balsamorrhiza deltoidea.* Balsam root. Almost entirely late summer use.

10 *Brassica campestris.* Common yellow mustard. Eaten sparingly in spring. Erosion-control seeding of this species may promote feeding; dense patches, however, usually show very little utilization. As with cattle, the leaves are often stripped from the mature plants in isolated patches. This species and others are sufficiently common on all coastal grazing lands to warrant mention.

20 *Capsella bursa—pastoris.* Shepherds purse.

10 *Castilleia.* Indian paint brush.

20 *Chlorogalum.* Soap plant. Spring use entirely.

20 *Crepis acuminata.* Hawks beard.

10 *Dodecatheon patulum.* Shooting star.

20 *Echinocystis fabacea.* Chilicothe. Dried leaves and tendrils eaten. Common in burns of coastal range.

20 *Epilobium paniculatum.* Fire weed.

20 *Eriogonum fasciculatum.* Wild buckwheat, flat top. The buckwheats are valuable forage plants, primarily because of their wide distribution, abundance, and ability to grow in arid areas. The dried heads are used during fall and winter. The genus is large, but all species found were of importance.

90 *Erodium cicutarium.* "Fillaree". An excellent forage plant. All species are eaten whenever found, and throughout the year, whether green or dry.

10 *Eriodictyon californicum.* Yerba santa. Quite common, but only the fresh green buds eaten.

20 *Helianthella* spp. Sunflower. The heads and upper stems eaten in fall, and some dried leaves in winter.

10 *Heracleum lanatum.* Cow parsnip.

20 *Iris* spp. Iris, flags. Dried herbage, and occasionally flowering parts.
10 *Layia platyglossa.* Tidy tips. Mostly in spring.
40 *Lathyrus.* Peavine. Spring and fall use. Cultivated species eaten extensively.
60 *Leontodon taraxacum.* Dandelion.
20 *Lepidium nitidum.* Common pepper-grass. Spring and summer.
20 *Lomatium.* Hog-fennel.
30 *Lotus* spp. Lotus. Small decumbent species. Mostly in spring.
30 *L. scoparius.* Deer weed. Very common on burned areas. Scattered bushes are well eaten, but dense patches are of correspondingly lower value.
Lupinus. Lupine. The bush or shruby form 30, tall succulent species 20, low appressed species found on rocky soils 50. The pods of the lupines do not seem to be eaten, but the leafage is often stripped and the upper stems eaten after frosts.
30 *Malva parviflora.* Cheese weed. A shrubby plant, and well eaten in spring.
20 *M. rotundifolia.* Dwarf mallow. Cropped only when small.
90 *Medicago hispida.* Bur clover. An esteemed forage plant, green or dry. All species eagerly eaten yearlong.
80 *M. sativa.* Alfalfa. Alfalfa fields near the forest are eaten closely by deer. Alfalfa hay is considered the best supplemental forage for winter feeding.
30 *Melilotus alba.* White sweet clover.
Both species only moderately eaten.
30 *M. indica.* Yellow sweet clover.
20 *Mimulus.* Monkey flower. Annuals fairly well eaten; perennials untouched.
20 *Montia perfoliata.* Miners lettuce. Eaten only in spring. Use varies with type of cover.
20 *Nemophila* spp. Baby blue-eyes.
20 *Oenothera* spp. Evening primrose. Basal leafage.
10 *Orthocarpus* spp. Owls clover. Spring use.
20 *Osmorrhiza nuda.* Sweet cicely.
10 *Paeonia brownii.* Western peony.
20 *Phacelia* spp. Phacelia. Spring use of the annuals only.
10 *Plagiobothrys* spp. Popcorn flower. Spring use.
30 *Potentilla* spp. Five fingers. Fall use.
10 *Pteris aquilina.* Bracken, fern. The young shoots appear to be the only parts eaten; large fronds untouched.
30 *Ranunculus californicus.* California buttercup. Spring and summer.
10 *Salvia columbariae.* Chia, sage.
10 *S. leucophylla.* Purple sage.
Utilization of the Salvias varies considerably, but they are believed to be of low value.
10 *S. mellifera.* Black sage.
— *Senecio.* Groundsel. The senecios may be roughly segregated into dry-land species 10-20, and those requiring a moist soil 30-40.
20 *Sidalcea malvaeflora.* Checker bloom, mallow.
30 *Spraguea umbellata* (*Calyptridium umbellatum*). Pussy paws. Eaten freely in spring whenever found. Is quite common on firebreaks and roadsides.

80 *Trifolium* spp. Clover. All species of this valuable genus are much sought after. Cultivated varieties of *Trifolium* used as cover crops are very attractive to deer.

60 *Vicia americana.* Vetch, pea-vine. Apparently relished best in fall, when both dried leafage and vines are well utilized.

60 *V. sativa.* Common vetch.

20 *Viola.* Violet. Spring and summer.

20 *Vitis californica.* California wild grape. Tender parts and ripe fruit.

10 *Yucca whipplei.* Yucca. The flowering stem when green is often eaten, and occasionally some leafage.

GRASSES

30 *Agropyron tenerum.* Wheat grass. Good usage in spring, but only the heads and upper stems eaten in summer.

30 *Agrostis palustris.* Red top.

20 *Aira danthonioides.* Hair grass.

20 *A. elongata.*

20 *Avena fatua.* Wild oat. Little use in spring when small. The heads, upper stem during summer, and small portions of dried leafage in fall. Dense patches show only occasional use. Eaten sparingly after first rains. It is, however, a useful forage plant in winter.

20 *Bromus hordeaceus.* Soft cheat.

30 *B. marginatus.* Brome grass. The ripe heads show fairly constant use.

10 *B. rubens.* Red brome.

10 *B. rigidus.* Ripgut brome. This and red brome are mostly of value in early spring, though there is probably some use made in late fall and winter of the dry leafage when choicer forage is scarce.

30 *Cynodon dactylon.* Bermuda grass, devil grass. Limited in location, but valuable wherever found.

10 *Distichlis spicata.* Salt-grass.

30 *Elymus condensatus.* Giant rye grass. The heads and upper stems are cropped regularly, but leafage shows only fair utilization. Excessive use often indicative of other forage scarcity.

30 *E. glaucus.*

10 *Epicampes rigens.* Deer-grass. Rarely eaten, this grass is certainly misnamed.

40 *Festuca* spp. Perennial species. The perennials are well eaten when young and all parts cropped. Mature grasses, however, show the usual habit of use by deer in that the heads only are eaten.

20 *Festuca* spp. Annuals. Utilization seems uniform only when succulent.

10 *Hordeum jubatum.* Squirrel-tail barley.

10 *H. murinum.* Wild barley, fox tail. An annual of value only when green.

30 *Lolium multiflorum.* Italian rye grass.

30 *Melica bulbosa.* Onion grass.

30 *M. imperfecta.* Onion grass.

50 *Poa pratensis.* Kentucky blue grass. This choice perennial grass is closely cropped when green.

30 *P. compressa, P. scabrella,* and *P. sandbergii.* All these perennials show only the heads and stems as being eaten consistently.

10 *Sitanion hystrix.* Squirrel tail. This and *S. jubatium* are used only when green. Main value lies in wide distribution.

20 *Stipa pulchra.* Porcupine grass, pine grass. This species and others found were only cropped occasionally. The dried leafage showed little use in winter.

SUMMARY. The utilization of the perennial bunch grasses seems to vary to some extent with climatic conditions. Dry years, when these grasses mature early and remain harsh and unpalatable for a long time, affect their value as forage for both deer and domestic stock. The seasons when they are most used are spring and early fall. Where fed tame hay, deer usually eat the heads and upper stems first and will rarely clean up the coarser stems unless very hungry.

GRASSLIKE PLANTS

50 *Carex* spp. Sedge. Small wet-meadow sedges are closely eaten. The coarse, tall-growing species, and those growing on dry land, are almost untouched and are of negligible value and quantity.

50 *Juncus* spp. "Wire grass", rushes. The same valuation may be given the rushes found in wet-meadow types or stream beds.

— *Typa latifolia.* Common cat-tail. Found in marshy places and along sides of reservoirs, etc. Of low value as forage and usually untouched.

LICHENS

The trailing lichens found on oaks near the coast are eaten in fall, and those growing on the trunks of coniferous trees are cropped quite consistently and, if food is scarce, very closely, especially in winter.

MUSHROOMS AND FUNGI

Deer seem to have a marked fondness for certain species growing under pine and fir trees. Apparently they have a keen nose for these delicacies, and will paw away the litter to find them.

MISTLETOE

Mistletoe is quite common and is readily eaten by deer and also cattle. Often when an infested tree is felled the mistletoe is eaten first.

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THE APPLICATION OF FOURIER'S SERIES IN FOREST MENSURATION

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FOURIER'S series has not received the attention from American mensurationists that it merits. The German forester Hohenadl (1, 2), as pointed out by Meyer (3), advanced the hypothesis that this series had unlimited possibilities in forest mensuration, not only for periodic trends but also for nonperiodic (see Figure 1), such as height, volume, taper, growth, and yield curves, and also frequency distributions such as stand tables. As yet no one has demonstrated this. The objects of this paper are, first, to introduce Fourier's series as a statistical tool to those unfamiliar with it; second, to show the simplicity of fitting this series; third, to show its flexibility; and finally, to demonstrate its general applicability to the curve types encountered in analysing forestry data.

Characteristics of Fourier's Series

Fourier's series is an infinite trigonometric series consisting of alternate sine and cosine terms as follows:

$$(1)\quad F(X) = A_0 + A_1 \sin x + A_2 \sin 2x + \ldots \pm A_n \sin nx + B_1 \cos x + B_2 \cos 2x + \ldots \pm B_n \cos nx$$

In fitting this series, the ideal to strive for is a representative trend consistant with the precision of the data, but with as few terms as possible.

Mathematicians have demonstrated that Fourier's series may be used to represent any single-valued finite function, F(x), that is continuous and has a finite number of maxima and minima within the interval $-\pi$ to $+\pi$. By single-valued is meant that each value, x, of the independent variable has only one y value. In other words, a line perpendicular to the x axis intersects the curve but once. By finite is meant that no ordinate goes to infinity. To be continuous a function does not necessarily have to meet the condition that small changes in x must be accompanied by small changes in y. A finite number of large and abrupt changes for small changes in x are allowable, so long as they are not infinite. Since these limitations do not usually occur in empirical data, they do not present any difficulties.

One disadvantage of Fourier's series is that values outside the range of the raw data cannot be calculated by the derived equation.

The curve represented by equation 1 is periodic. It has the same shape for consecutive intervals of 2π, i.e., from 0 to 2π, from 2π to 4π, etc. In practice, only that part of the curve in the interval from 0 to 2π is fitted to the data. As will be seen later, the range of the independent variable is arbitrarily spread over this interval.

The ordinates of the final curve derived by a Fourier's series is a composite curve built up by the addition of the component curves of the series. These internal components, up to and including only the second harmonic, are as follows:

[1]The author wishes to acknowledge his indebtedness to Prof. R. M. Brown of the University of Minnesota, Division of Forestry, for valuable suggestions and criticisms in the preparation of this paper.

$F(x) = A_0$	mean ordinate
$+ A_1 \sin x + B_1 \cos x$	fundamental vibrations
$+ A_2 \sin 2x + B_2 \cos 2x$	first harmonic
$+ A_3 \sin 3x + B_3 \cos 3x$	second harmonic

To show this more specifically, the actual components of the symmetrical frequency distribution of example 1, Table 1, are given as follows:

$F(x) = 22.83$	mean ordinate
$-5.53 \sin x - 25.83 \cos x$	fundamental vibration
$+ .92 \sin 2x + 3.90 \cos 2x$	first harmonic
$+ .94 \sin 3x + .47 \cos 3x$	second harmonic

How the final curve is built up is clearly shown in Figure 1, curve A. Note particularly that for each successive harmonic the amplitude is much less, but the number of waves is increased.

In actual practice either the complete series, consisting of both the sine and cosine terms, or the sine or cosine series alone may be used. The combination, however, gives a much more flexible and general method and is especially adapted to periodic curves, e.g., frequency distributions. The sine or cosine series alone are less flexible, but are more valuable for defining non-periodic trends, as e.g., growth, height, and volume curves.

In fitting this series the number of terms which will apear in the final equation depends entirely upon the particular trend of the data. No hard and fast rules can be laid down as to the number of terms which will appear in the final equation but in general, only two to four terms are necessary to give a representative trend. However, as the number of terms are increased the corrections become smaller and smaller, until finally the series converges to the actual points on the curve.

The general applicability of Fourier's series is not impaired by the particular range of values of the independent variable, i.e., the minimum value may be equal or greater than zero because the range of the independent variable is arbitrarily spread over the range from 0 to 2π. This is analogous to shifting axes so that the minimum value of the independent variable agrees with the zero value.

Fitting Fourier's Series

Theory.—This series may be fitted to data by two general methods: (1) The formal mathematical method and (2) The semigraphical empirical method. Which of these two methods will be used depends entirely upon the available information. If the mathematical function (F(x) is known, the formal method is used; if unknown, the empirical method. Obviously the second approach is the one that chiefly concerns the forest mensurationist.

Formal Method.—If the functional equation is known, the coefficients, A_0, A_1, A_2, etc., and B_1, B_2, etc., may be evaluated by substituting the known equations in the following integrals and integrating them by the formal methods of the calculus.

$$(2) \quad A_0 = 1/2\pi \int_0^{2\pi} F(x)\, dx$$

$$(3) \quad A_1 = 2/2\pi \int_0^{2\pi} F(x) \sin x\, dx$$

$$(4) \quad B_1 = 2/2\pi \int_0^{2\pi} F(x) \cos x\, dx$$

The third and fourth integrals may be generalized for any A coefficient other than A_0, and for any B coefficient, as follows:

$$(5) \quad A_n = 2/2\pi \int_0^{2\pi} F(x) \sin nx dx$$

$$(6) \quad B_n = 2/2\pi \int_0^{2\pi} F(x) \cos nx dx$$

Since this method has such little practical value, the details of it will not be given.

Empirical Method.—If the function is not known, several methods may be used. Because of its simplicity and wide ap-

plicability, the so-called mean-ordinate method is recommended. To fit a Fourier's series by this method, a smooth curve is first drawn through the plotted points, and curved values read for each independent variable class. Then the range of the independent variable is arbitrarily spread over a range of 0 to 2π, i.e., from 0° to 360°. The actual range of the independent variable is converted to degrees by merely dividing 360° by the number of classes into which the actual independent variable has been divided. For example, if the data have been grouped into 12 one-inch diameter classes, then each class will be represented by $\frac{360°}{12}$ or 30°, as shown in the example in Table 1. These angles are tabulated with their natural sines and cosines and their functions, as shown in Table 1. In each case the proper sign of the angle is indicated.

To determine the coefficients by this method, the following equations are used:

$$(7)\quad A_0 = \frac{S\ F(x)}{n}$$

$$(8)\quad A_1 = \frac{2}{n}\ S\ [F(x)\ \sin x]$$

$$(9)\quad B_1 = \frac{2}{n}\ S\ [F(x)\ \cos x]$$

where n is the number of classes into which the range of the independent variable is arbitrarily divided.

The coefficients A_2—A_n are determined by merely replacing sine x in equation 8 by sine 2x, or, in general, by replacing sine x by sine nx; and B_2—B_n by replacing cos x in equation 9 by cos 2x, or by replacing cos x by cos nx.

The coefficient A_0 is merely the mean of the n ordinates read from the smooth curve. The coefficient A_1 is computed by multiplying each ordinate by the sine of the abscissa angle, adding these products, and multiplying this sum by the ratio $\frac{2}{20}$.

The coefficient B_1 is computed in similar manner, but using the cosine of the angle instead of the sine.

The remaining coefficients are computed by the same method, using the functions of sines and cosines, sine 2x—sine nx and cos 2x—cos nx.

Application to Actual Data

To illustrate the arithmetic involved in the mean-ordinate method, Fourier's series will now be fitted to actual data.

FITTING FREQUENCY DISTRIBUTIONS

Symmetrical Diameter Distribution.—As stated previously, the first step in the procedure is to plot the data and draw a smooth curve through the points as shown in Figure 1, curve B. For each of the 12 diameter classes, a curved value of the number of trees is read from the curve and tabulated, as in Table 1, columns 1 and 2. Next each diameter class is expressed in degrees. Since in this example there are 12 diameter classes, each is represented by $\frac{2}{12}$ or 30°. The range of the 2-inch diameter class is therefore from 0 to 30°, the 4-inch class from 30° to 60°, etc. Then assuming that the number of trees is concentrated at the midpoint of each class, the angles for these points are 15°, 45°, etc., as shown in column 3 of Table 1. Next the natural sines and cosines of these angles and their functions are tabulated with their proper signs, columns 4 to 9, Table 1.

Determination of the Coefficients.—The coefficient A_0 is computed by totaling the number of trees and dividing by the number of diameter classes. In this example it is $\frac{274}{12}$ or 22.83 trees.

To obtain the A_1 coefficient, the number of trees for each diameter class is multiplied by the sine of the angle and these products totaled and this total mul-

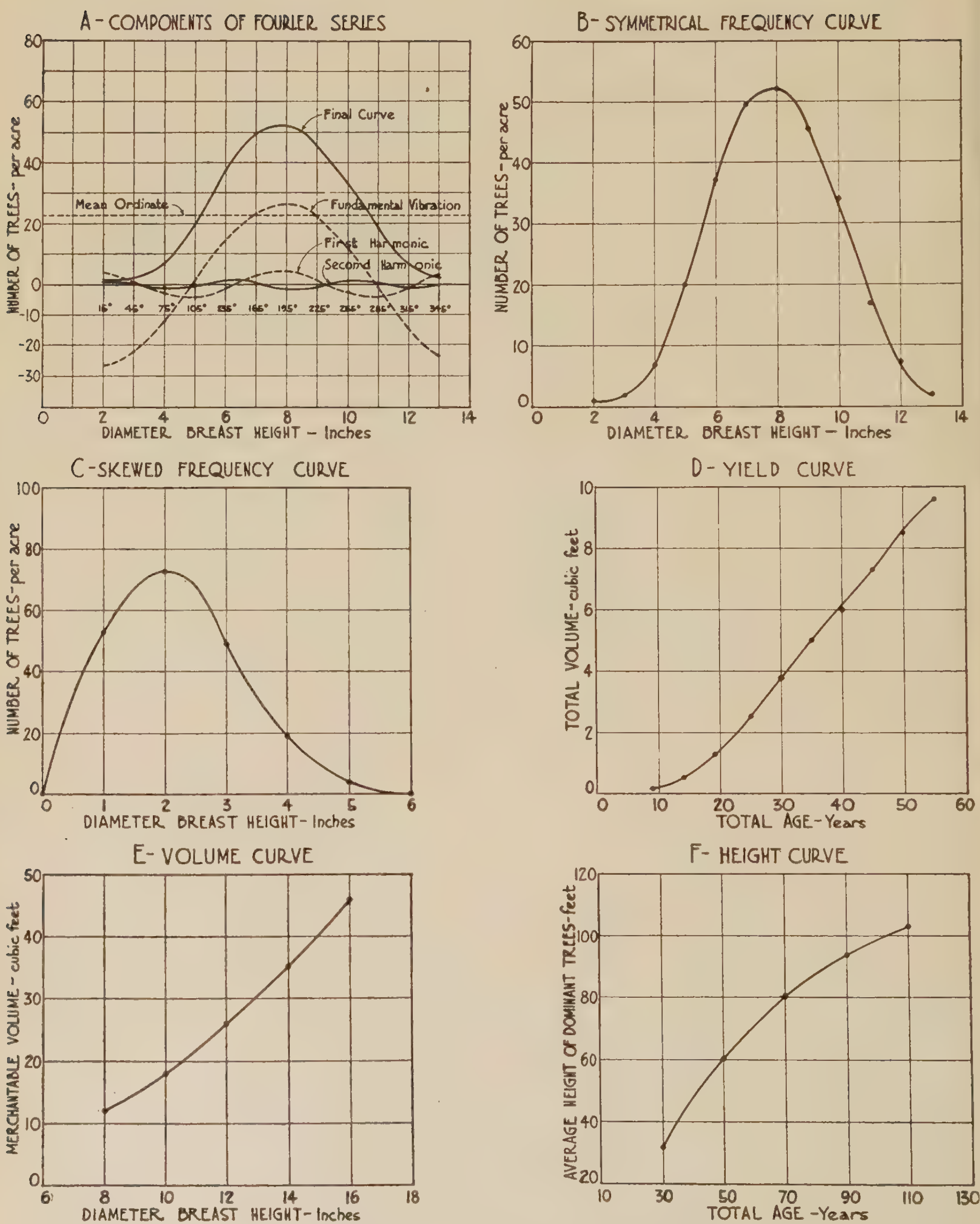

Fig. 1.—Application of the Fourier series to common problems in forest mensuration. A, components of the series. B-F, original values (from free-hand curves) compared with Fourier series.

tiplied by $\frac{2}{12}$, as follows:

$$A_1 = \frac{2}{12} \left\{ 1(+.259) + 2(.707) + 7(+.966) + 20(+.966) + 37(+.707) + 50(+.259) + 52(-.259) + 45(-.707) + 34(-.966) + 17(-.996) + 7(-.707) + 2(-.259) \right\} = \frac{-33.15}{6} = -5.53$$

The amount of work can be greatly reduced by collecting all similar terms, or, better, by accumulating them on a calculating machine. All of the other coefficients are computed in a similar manner, using the proper trigonometric functions. These computations are shown at the bottom of Table 1.

Derivation of Final Equation.—By substituting these coefficients in equation 1, the final equation is derived. In this example it is as follows:

$$F(x) = 22.83 - 5.53 \sin x + .92 \sin 2x + .94 \sin 3x - 25.83 \cos x + 3.90 \cos 2x + .47 \cos 3x$$

In order to solve this equation, the natural sine and cosines and their functions are substituted in it. For example, the curved number of trees for the 10-inch diameter class is computed as follows:

Number of trees $= 22.83 - 5.53\ (-.966) + .92\ (-.500) + .94\ (+.707) - 25.83\ (+.295) + 3.90\ (-.866) + .47\ (-.707) = 32.93$ trees.

The curved values are given in column 10, Table 1.

Testing Goodness of Fit.—Pearson's chi-

TABLE 1

METHOD OF FITTING FOURIER'S SERIES BY THE MEAN-ORDINATE METHOD

(1) Diameter Class	(2) Number of Trees	(3) Diameter in degrees	(4) Sin-x	(5) Cos-x	(6) Sin-2x	(7) Cos-2x	(8) Sin-3x	(9) Cos-3x	(10) Computed number of trees	(11) Deviation	(12) Deviation squared divided by computed
2	1	15	.259	.966	.500	.866	.707	.707	1.28	— .28	.061
3	2	45	.707	.707	1.000	.000	.707	—.707	1.91	+ .09	.004
4	7	75	.966	.259	.500	—.866	—.707	—.707	6.89	+ .11	.002
5	20	105	.966	—.259	— .500	—.866	—.707	.707	20.01	— .01	.000
6	37	135	.707	—.707	—1.000	.000	.707	.707	37.25	—. 25	.002
7	50	165	.259	—.966	— .500	.866	.707	—.707	49.60	+ .40	.003
8	52	195	—.259	—.966	.500	.866	—.707	—.707	52.06	— .06	.000
9	45	225	—.707	—.707	1.000	.000	—.707	.707	45.59	— .59	.008
10	34	255	—.966	—.259	.500	—.866	.707	.707	32.93	+1.07	.035
11	17	285	—.966	.259	— .500	—.866	.707	—.707	17.97	— .97	.052
12	7	315	—.707	.707	—1.000	.000	—.707	—.707	6.57	+ .43	.028
13	2	345	—.259	.966	— .500	.866	—.707	.707	1.90	+ .10	.005
Total	274				Product sum				273.96	+ .04	.200
			—33.15	—155.01	+5.50	+ 23.38	+5.66	+2.83			

$$A_0 = \frac{274}{12} = 22.83$$

$$A_1 = \frac{-33.15}{6} = -5.53 \qquad B_1 = \frac{-155.01}{6} = -25.83 \qquad X^2 = .200$$

$$A_2 = \frac{+5.50}{6} = .92 \qquad B_2 = \frac{23.38}{6} = 3.90 \qquad P = .91$$

$$A_3 = \frac{5.66}{6} = .94 \qquad B_3 = \frac{2.83}{6} = .47$$

$$F(x) = 22.83 - 5.53 \sin x + .92 \sin 2x + .94 \sin 3x - 25.83 \cos x + 3.90 \cos 2x + .47 \cos 3x$$

square[2] test was applied to the curved values to test the goodness of fit, as shown in column 12, Table 1. Since in this case the independent variable has been divided into 12 groups and 7 constants have been used in fitting the curve, the number of degrees of freedom are 12-7, or 5. For five degrees of freedom, the proportion of random samples that will have a chi-square equal to or greater than .200 is more than .91. Because the proportion of samples is large, the deviation from the Fourier's series can be considered random sampling errors: and therefore, the fit a good one.

Skewed Diameter Distributions.—In order to demonstrate its flexibility, the Fourier's series will now be fitted to a skewed diameter distribution. For this purpose the diameter distribution of a young, pure, even-aged and well-stocked stand of Norway pine was used (see curve C). The actual and computed values are shown in Table 2. Since the deviations are so small in this example, the chi-square test is not necessary to show that for all practical purposes the deviations are random sampling deviations, and the curve therefore a good fit.

TABLE 2

SHOWING APPLICABILITY OF FOURIER'S SERIES TO A SKEW FREQUENCY DISTRIBUTION

Diameter class	—Number of trees[1]— Actual	Calculated	Deviation
1	53	53.1	—.1
2	73	73.0	0
3	49	49.0	0
4	19	19.0	0
5	4	3.9	+.1
Total	198	198.0	0.0

$A_0 = 39.6$ $B_1 = -12.5$

$A_1 = 32.1$ $B_2 = -3.1$

$A_2 = 6.0$

$$F(x) = 39.6 + 32.1 \sin x + 6.0 \sin 2x - 12.5 \cos x - 3.1 \cos 2x$$

[1]Data on yield of well stocked even-aged stands of Norway pine were collected by R. M. Brown, Division of Forestry, University of Minnesota.

FITTING TREND RELATIONSHIPS

Growth and Yield Curves.—Another common curve type encountered in forest mensuration is the typical S-shaped growth curve, such as the volumes or yields of individual trees or stands of different ages, as shown in Figure 1, curves D and F. In order to test the adaptability of the Fourier's series for representing these trends, data on the volume of an individual tree at different ages were obtained from stem analysis measurements by calculating the volume in cubic feet of the tree at 5-year intervals (see Table 3). When only the sine or cosine series is used, the interval of integration is 180° instead of 360°. The values calculated by the cosine series are given in Table 3. The differences between the actual and calculated yields are so small that they are without practical significance.

Volume Curves. — Another common curve type is the relationship of volume to diameter at breast height for trees of

TABLE 3

COMPARISON OF THE GROWTH IN VOLUME OF AN INDIVIDUAL TREE WITH THE VALUES CALCULATED BY FOURIER'S SERIES

Age	——Volume—— Actual	Calculated	Deviation
Years	*Cubic feet*		*Cubic feet*
9	.13	.15	—.02
14	.53	.49	+.04
19	1.25	1.30	—.05
24	2.53	2.50	+.03
29	3.81	3.82	—.01
34	5.01	5.00	+.01
39	6.03	6.08	—.05
44	7.42	7.32	+.10
49	8.52	8.65	—.13
54	9.64	9.59	+.05
Total	44.87	44.90	—.03

$A_0 = \dfrac{44.87}{10} = 4.49$ $B_3 = -.27$

$B_1 = 4.53$ $B_4 = +.18$

$B_2 = +.24$

$$F(x) = 4.49 - 4.53 \cos x + .24 \cos 2x - .27 \cos 3x + .18 \cos 4x$$

[2]One objection that may be raised in applying this test to curves fitted by the mean-ordinate method is that this method does not meet Fisher's criteria of sufficiency and efficiency.

given total or merchantable heights. Average volumes were read directly from the volume table for aspen[3] for the 80-foot height class. Tabular volumes were used instead of raw averages. This procedure does not affect the final results, because the final criterion of a good fit is a representative trend, Figure 1, curve E. As shown in Table 4, the differences between the actual and calculated volumes were insignificant.

Age-Height Curves.—In this test, tabular values of average height of dominant trees over age were read from a white pine yield table.[4] Table 5 shows how closely the Fourier series fits these data.

Summary

This paper explains the theory and characteristics of Fourier's series; and demonstrates by concrete examples the ease with which it can be fitted to data; the close agreement between actual and curved values; its flexibility and general applicability to the types of distributions and trends encountered in forest mensuration. Because of these characteristics, Fourier's series should be included in all forest mensurationists' statistical tool kit.

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Table 4

COMPARISON BETWEEN THE ACTUAL VOLUME OF ASPEN AND VOLUMES CALCULATED BY FOURIER'S SERIES

Diameter class	Average volume: Actual	Average volume: Calculated	Deviation
Inches	*Cubic feet*		*Cubic feet*
8	12	12.0	0
10	18	17.9	+.1
12	26	26.0	0
14	35	35.1	—.1
16	46	46.0	0
Total	137	137.0	0.0

$A_0 = 27.4$ $B_1 = 1.8$
$A_1 = -14.5$ $B_2 = .4$
$A_2 = -8.9$
$F(x) = 27.4 - 14.5 \sin x - 8.9 \sin 2x + 1.8 \cos x + .4 \cos 2x$

Table 5

COMPARISON OF THE ACTUAL AVERAGE HEIGHT OF DOMINANT WHITE PINE TREES OF VARYING AGES WITH THE HEIGHTS CALCULATED BY FOURIER'S SERIES

Age class	Average heights of dominant trees: Actual	Average heights of dominant trees: Calculated	Deviation
Years	*Feet*		*Feet*
30	32	32.0	.0
50	60	60.1	—.1
70	80	80.1	—.1
90	94	93.9	+.1
100	103	103.0	.0
Total	369	369.1	—.1

$A_0 = 73.8$ $B_1 = -7.4$
$A_1 = -29.6$ $B_2 = -1.1$
$A_2 = -19.0$
$F(x) = 73.8 - 29.6 \sin x - 19.0 \sin 2x - 7.4 \cos x - 1.1 \cos 2x$

[3]University of Minnesota, Agricultural Experiment Station Tech. Bull. 39, table 18, p. 31.

[4]University of Minnesota, Agricultural Experiment Station Tech. Bull. 39, table 173, p. 204.

BRIEFER ARTICLES AND NOTES

A New Holly

Ilex nettletoniana Ferguson, n. sp. (Royal Holly) is a little known evergreen holly which has apparently escaped a botanical description up to this present time. No mention of it could be found in the recently revised Manual of the Trees of North America by Sargent, or in any other tree manual.

This attractive tree, though not plentiful, can be found in moist river bottoms and along banks of small streams. The specimens observed were small, about 20-30 feet in height with a diameter of 6-8 inches. Maximum size is not known. Leaves and berries of this tree are brighter and more glossy than those of the *Ilex opaca.* The most distinguishing characteristic, however, is the leaf, which has a smooth margin. Very rarely a leaf can be found with a spinose tooth or with a tendency for the same.

Leaves: simple, alternate, obovate with thickened margins, entire, apex a spine; coriaceous, glossy, dark yellow-green, paler underneath, with prominent midrib, but not conspicuous veins, 2 to 4 inches long, usually twice as long as broad; persistent for three years: petioles short, stout, and grooved above.

Flowers: very small and white, appear in the spring; scattered along the base of the new shoots.

Fruits: ripens in late autumn, persistent on branches during winter; ovoid, bright-red, 3/8-inch in diameter, borne singly on stems 1/4-inch long and 4 to 6 berries in a cluster around the new shoot; nutlets prominently ribbed on back and sides.

Bark: about 1/4-inch thick, mottled-gray, smooth with occasional wart-like excresences.

Wood: light, tough, close-grained and white.

Distribution: lightly scattered in Winn Parish, La., in river bottoms or along banks of streams in rich, humid soil. Range is not known.

Remarks.—The characters which separate this specie from its closest relatives are as follows:

Ilex nettletoniana	*Ilex opaca*	*Ilex cassine*
Leaves generally entire, with a rarely occasional spinose tooth, 2 to 4 inches long, twice as long as broad. Fruit usually solitary, bright red. Bark about 1/4-inch thick.	Leaves generally with spinose teeth and are occasionally entire, 2 to 4 inches long. Fruit usually solitary, dull red. Bark about 1/2-inch thick.	Leaves entire or sometimes serrate above the middle, 1 1/2 inches long, 1/2 to 1 inch wide. Fruit solitary or in clusters of two or three. Bark about 1/16-inch thick.

Roland H. Ferguson,
Kisatchie National Forest, La.

Fig. 1.—Royal holly (*Ilex nettletoniana*).

Reform of Yield Tables

Under the title "Misuse of Yield Tables" (page 438) in the Journal of Forestry of April 1935, Francis X. Schumacher commented on an article entitled "Stand Basal Area Curves in American Yield Tables" in the January 1935 issue.

Although it may be worse in a conservative professional group to be branded a "reformer" than a "misuser", nevertheless a reply has been planned for a long time under a reform title. It was to have included graphs and charts, and citations of chapter and verse. But repeatedly its preparation was deferred to make way for pressing or more enticing jobs. Not to wait longer for time and inclination to dig deeply into a subject so remote from my regular work, and yet to make some effort to be absolved as a "misuser" of yield tables, this brief reply is made.

The specific misuse charge is that information on the relation of stand-basal area to average-stand-diameter was sought in yield tables, whereas it should only be determined through the "laborious task" of digging for it in raw data.

There can be no argument with this, if and when it is the object to determine the "true relationship" of the two variables. But that was not the object in this case. Instead, the erratic relationships *as read from yield tables* were exhibited to disclose what are felt to be deficiencies in American yield tables. It was hoped to provoke appropriate reforms. The job was not done by a yield-table expert, but by a user who had found many of the tables wanting for practical purposes. One of those purposes was the development of a rough index of normality, expressable in basal-area-per-acre or number-of-trees-per-acre as related to average-stand-diameter. Such an index could be applied without determining plot age. Therefore, it was felt that it would be of considerable practical value. But the yield table values showed such erratic trends the attempt was abandoned. Time did not permit going to original, raw data to find the "true relationships".

The "misuse" paper states that "some 20 to 50 per cent of the variance of both stand-basal-area and average-stand-diameter are independent of age and site quality, and these parts are not in Foster's pictures." Since "Foster's pictures" merely show the relation of values as given in the yield tables, the conclusion of course is that the tables show only 50 to 80 per cent of the variance of these two variables. Yet (in stands of given average-diameter) basal-area-per-acre is so closely related to stand-volume that the yield values in a yield table can be assumed deficient to very nearly the same extent as the basal area values. Nevertheless, stand-basal-area values are so erratic in most American yield tables that changes up to 100 per cent or more would be required to correct the erratic behavior shown in "Foster's pictures" and to make the values conform to trends which Mr. Schumacher says are "emphatically" to be expected of these variables. One's faith is badly shaken by such observations. Is it unreasonable to demand tables which show more than 50 to 80 per cent of such important variances? Merely because 20 to 50 per cent of the variance is dependent on factors other than age and site quality, is that any reason for leaving it out of the yield tables?

One approach for making yield tables show more of the variance of such variables might be through the use of average-stand-diameter instead of age as the in-

dependent variable at certain stages in the yield table procedure. Gevorkiantz and Zon did this in preparing a white pine yield table.[1] This is one of the few American tables which shows the "emphatically" expected trend of stand-basal-area curves. Whether or not the use of average-stand-diameter has any relation to that fact, I am not expert enough to say. But it might be worth investigating.

The reason for my confidence in average-stand-diameter is based on a very simple observation: namely, when average-stand-diameter is used as the independent variable, raw data such as volume, stand-basal-area, etc., plot into a much narrower band than when age is used. An indication of the extent to which this is true can be readily obtained by plotting the values of these variables as given in yield tables. On one sheet use age as the independent variable. On the other use average-stand-diameter. On each sheet plot the data for several site classes. Note how much closer together the curves are on the latter sheet than on the former. Drawing several related curves through data that fall in a narrow band, of course, requires much closer fitting than when the data are widely scattered over a broad band. Closer fitting, in turn, should produce curves which conform more closely to actual trends. Hence yield tables derived from them should be more accurate.

Ellery Foster,
U. S. Forest Service.

As Others See Us

One does not willingly introduce an inharmonious suggestion at a wedding feast or at a birthday party. Yet sometimes the guests at a matrimonial celebration or at a birthday anniversary become so hilarious that it is well to remind them that their neighbors may be somewhat annoyed by the manner in which they are asserting themselves.

I believe some one should raise a mild objection to certain assumptions in the editorial in the January number of the Journal of Forestry. A large number of men now in the Forest Service of the Department of Agriculture, or who have been connected with that Service in the past, have been imbued and saturated with the idea that the Forest Service of the Department of Agriculture has for the last thirty-five years been the only Simon-pure, duty-conscious, efficient Bureau or Service in the federal government. This has not been the attitude of all members of the Forest Service and I am sure it is not the deliberate opinion of the most sincere and fair-minded Editor of the Journal. I do not present these comments in a controversial spirit but rather as an appeal to those who, heretofore, have not subjected themselves to a searching self-examination.

I would be the last to contest a statement that the Forest Service has, throughout its entire existence, been an efficient organization, guided by the highest motives of public service. I could not pay too warm a tribute to the high ideals of the scores of prominent men in the Forest Service whom I have known, nor do I underestimate in the least the fine *esprit de corps* that has generally characterized the entire Forest Service.

With the statement that there was a conscious purpose in 1901 "to build an organization that would be different from the ordinary run of government bureaus", I would willingly agree; but I wonder if the writer of the editorial would as

[1]Second growth white pine in Wisconsin. Univ. of Wisc. Research Bull. No. 98. 1930.

readily agree with me that such purpose frequently fell far short of fulfillment, and that some of the insidious faults that have affected other bureaus have also seriously affected the Forest Service.

With the assertion that the Forest Service is "outstanding for its difference from the norm of federal bureaus", I cannot so readily agree. I admit that I have never been in as intimate contact with other bureaus in the Department of Agriculture; but such contact as I have had has not led me to the conclusion that the employees in such bureaus were inferior to those of the Forest Service in intelligence, education, training, devotion to the government service, or efficiency in their work. My impression is that the Public Health Service, the Coast Guard Service, and the Revenue Service have many employees who are outstanding in efficiency, and that in every one of these services the personal risks assumed and the devotion to duty exhibited has certainly not been inferior to the hazards encountered or the zeal manifested by employees in the Forest Service.

While the editorial under discussion artfully avoids any comparison between the Departments of Agriculture and Interior, ninety per cent of the readers of the editorial were undoubtedly familiar with the fact that for nearly four decades foresters in the Department of Agriculture have maintained a decidedly critical attitude with respect to the Interior Department. On innumerable occasions the suggestion has been made that the bureaus in the Interior Department lacked the *esprit de corps* and the energetic devotion to the public service that foresters in the Agricultural Department fondly fancied were almost their exclusive possession. We can indulgently concede to them the satisfaction derived from self-admiration. In fact, such consciousness of superiority has undoubtedly been no small factor in driving the Forest Service forward to its remarkable achievements.

However, this attitude was largely the result of misunderstanding and has really been most unjust to a large number of men in various bureaus of the Interior Department; whose intelligent application to their work has equalled that of employees in the Forest Service. I am particularly familiar with the work of employees in the Indian Service, and still more particularly acquainted with the activities of men in the Forestry Branch of the Indian Service. I believe that it may be successfully established that during the twenty-three years following 1909 there was built up in the Indian Service a forestry organization that was possessed of as fine an *esprit de corps* as the Forest Service in the Department of Agriculture has ever had, and it is my belief that this spirit of devotion to high ideals still obtains.

Just as members of the Forest Service in the Department of Agriculture have been accustomed to think of their organization as superior in idealism, solidarity, and efficiency to other groups of federal employees, so men in the Forestry Branch of the Indian Service have been inclined to think that their solidarity and efficiency were superior to those of other groups in the Indian Service, with consequent annoyance of the other groups. Whatever superiority there may have been in these respects I am disposed to attribute to the character of the work on which they were engaged, rather than to an unusual perception of fundamental principles or any outstanding devotion to high ideals of public service. Forestry is an inspiring subject, and those who have chosen this profession have enjoyed an exceptional opportunity of interesting the man on the street in novel subjects and of winning his support. Foresters have taken the lead in the movement for the conservation of natural resources in America. They have been alert and determined, and can rightfully claim an honored place in public administration;

but, personally, I have not recognized a single superman among them, and it is somewhat humiliating for me to acknowledge that foresters often fail to achieve the very acme of ability and character, which is the capacity to form a just estimate of one's self.

J. P. Kinney,
Indian Service.

[*Editor's note.* The sounds mistaken for jubilating pæans of self-praise more nearly resembled a Lenten sermon. There was no intention in the January Journal editorial either to suggest or artfully to avoid a comparison between the Department of Agriculture and the Department of the Interior; no thought of such a comparison was in the mind of the writer. Nor was it intended to claim for the Forest Service preeminence over all other governmental units in *esprit de corps* and spirit of public service. The point made, and intended, was that the early success of the Forest Service was bound up with creating a Service different "from the *norm* of federal bureaus"; and to suggest that environmental influences, of which quarters are one, lighten or increase the task of any bureau chief concerned with maintaining the morale and teamwork essential for high-quality public service. The question meant to be raised was to what extent, with its present greatly enlarged responsibilties and personnel and with new headquarter conditions, the Forest Service has need to give careful thought to counteracting the downward drag of the forces that tend to make all federal bureaus less zealous, imaginative, vigorous, and united than the best public interest demands.—H. A. S.]

A Practical Tree-Marking Instrument

In forest management, when trees need to be designated for removal usually a portion of the bark is cut away, with either an ax or a timber scribe. Where the designation concerns trees to be left standing, they are commonly marked with chalk, crayon, powder, or paint. The application of chalk or powder with a claplet consumes probably the least time, and scribing the most. Paint applied with a brush from an open container is not completely satisfactory because of spillage and "messiness", but a painted mark is almost as permanent as a blaze, and has the additional virtue of not being confused with older or different marks. However, the major portion of marking cost is the time consumed in approaching the tree. This factor, and hence the cost, is quite variable and depends upon the slope, physical obstacles to travel, the

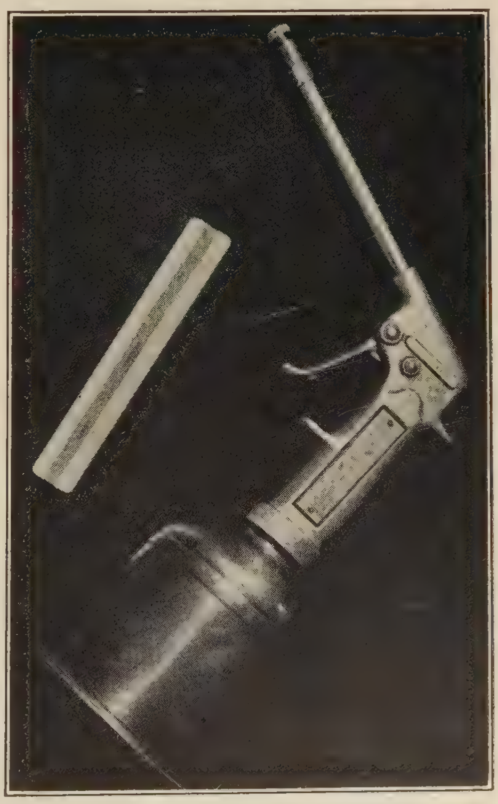

Fig. 1.—The Alemite Spring Spray Gun, Model 6121.

density of the timber, and the type and heaviness of marking.

In a study of forest management carried on by the Northeastern Forest Experiment Station at Cooperstown, N. Y., it was necessary to make a light uniform marking on areas of timber varying in size from 5 to 50 acres. To reduce marking costs, R. H. Rogers suggested using paint applied with a spray gun designed for spraying lubricating oil on inaccessible parts of automobiles. Under his direction a number of experiments on cost and methods were tried out. The device has been used continuously for over a year, and is considered satisfactory.

The implement is the Alemite Spring Spray Gun, Model 6121, manufactured by the Stewart-Warner Corporation and sold retail for $5.40 (Fig. 1). A trigger operates a self-contained spring pressure pump; no compressed air is used. The essential parts are a ¾-quart container for the liquid, the pump assembly, and the nozzle. Under favorable conditions the action will throw a solid stream of liquid 20 feet, with a practical working range of from 5 to 15 feet. The total weight of the gun when full of paint is 3¾ pounds.

The gun, designed for spraying light oils, must be altered slightly to make it suitable for handling paint. Two types of nozzles are available; the solid-stream type (HW-408), should be used. The orignial opening in the nozzle should be rebored to approximately 0.04 inches in diameter in order to get a satisfactory stream of paint. The intake valve of the pump contains a wire strainer which is too fine to allow the passage of paint; it should be removed before using. Beneath the trigger is an opening which should be packed with hard grease (S. A. E. 90) to prevent paint leakage and to provide lubrication for the trigger parts. Since the gun is designed for liquids lighter than paint, small parts such as leather washers and valve springs wear more rapidly than is normal, and must be replaced at intervals. A complete set of replacement parts costs about 35 cents.

Any type of liquid paint can be used if the mixture is thin enough to go through the gun and yet carry enough pigment to make a substantial mark on the tree. On the Cooperstown job 14 mixtures of paint and thinning agents were used, in which the amount of paint varied from 20 to 80 per cent. A mixture of half paint and half thinner works well and leaves a permanent mark. The type of thinning agent is apparently immaterial; turpentine, linseed oil, gasoline, and kerosene oil are satisfactory. Kerosene is the cheapest. A dryer is not needed.

Color is also immaterial, although white was probably the least satisfactory. Ordinary red oxide barn paint was the cheapest, gave a satisfactory mark on both light- and dark-barked trees, and does not expose the operator to the poisoning possible from lead-base paints. This paint can be purchased for $1.40 per gallon. With kerosene at 13 cents a gallon, a fifty-fifty mixture of paint and kerosene costs $1.53 per gallon, or about 38 cents per quart.

The technique involved in operating the gun is simple, but consideration must be given to a number of small details if operation is to be continuous. Paint should be purchased in one-gallon containers; so much sedimentation occurs in five- or ten-gallon containers that the maintenance of a uniform mixture is difficult. The mixture of paint and thinner should be strained through two thicknesses of cheesecloth. A funnel with a built-in metal strainer is not satisfactory because the strainer clogs easily. For an all-day operation, supplies of the strained mixture can best be carried in pint flask-shaped bottles, which can be thrown away when emptied, since they are cheap.

Any container can be used but a short time, due to sedimentation. The mixture has a high coefficient of expansion, and allowance for this must be made in filling the bottle.

If the gun plugs, it can often be cleared by pumping up as much pressure as possible and then hitting the nozzle a light glancing blow against the side of a tree; or the plug can be removed with a small piece of wire or a fine hairpin. If these means do not suffice, the gun must be taken apart. Consequently, when the gun is assembled it should be tightened with the fingers only, to make carrying a wrench unnecessary. If pressure can not be obtained from the pump because of displacement of the ball in the intake valve, the gun can be taken apart and the ball replaced on the valve seat.

The operator should be from 5 to 15 feet from the tree, depending upon windage. If closer, he may be splattered by the paint spraying back; if at a greater distance, the stream will break up and make too large and splattering a mark. A spot about 3 inches in diameter is considered standard. It is usually best to spray with the wind, not against it. The gun works well in summer or winter.

Before leaving the field, the operator should empty any remaining paint from the gun container, and if practicable fill it with water and pump until a clear stream comes from the nozzle. Upon returning to headquarters he should remove the pump from the container, place it in a can of kerosene, and pump it full. Once a month the pump and container should be thoroughly cleaned with paint remover. A small, stiff wire brush and a round brush for cleaning the inside of the barrel will be found useful.

Where the timber is open and the underbrush is not too heavy, marking with the gun takes about one-half the time required with an ax and one-third that with a timber scribe. On steep slopes, in extremely brushy areas, or in plantations the time saving with the gun may be considerably greater. Against this must be set the cost of the mixture. At 38 cents per quart, for this, about 4.6 trees can be marked with a 3-inch spot for 1 cent where one quart of the mixture suffices for 175 trees. This number, however, will vary widely. Rough-barked trees, which require relatively more paint than the above average, inability to shoot with the wind, and the operator's skill and self-restraint not to repeat shots unnecessarily all enter in.

If one man, at $5 per day, can mark 10 trees per acre on 50 acres with an ax, the cost is 1 cent per tree. With the gun, he should be able under the same circumstances to mark at least 100 acres per day, making the cost 0.50 cents per tree for labor and 0.21 cents for material, or 0.71 cents per tree. The net saving is 0.29 cents per tree, or $2.90 per day.

Spots made over a year ago on trees of all species and sizes in northern hardwoods are still visible at satisfactory distances. Properly used, the spring spray gun is an effective and economical instrument in forest management.

John B. Folsom,
Northeastern Forest Exp. Sta.

A Simple Log Rule

Various articles which have appeared in the Journal of Forestry show that there is a keen desire for some simple formula log rule that will meet the needs of the practical forester. The demand seems to be for a rule the values of which closely approximate those of the International Log Rule, ¼-inch kerf; for a rule that can be easily remembered; and

for a rule the values of which can be easily computed.

In an article in the February 1936 issue of the JOURNAL I attempted to show how closely Clement's Log Rule, by slight modification, approaches at least the first of the above conditions. As the purpose of the article was apparently misunderstood, it may be well to substitute another log rule which fulfills the desired conditions in that its values very closely approach those of the International Log Rule, it is easy to remember, and it is not difficult to compute. In order to avoid confusion this rule has been designated as the Sammi Log Rule, the formula for which is:

$$\text{Board foot volume} = (D - 1)^2 L/20$$

For a 16-foot log 26 inches in diameter at the small end, the calculations are:

$$(26 - 1)^2 16/20 = 0.8\ (25)^2 = 500 \text{ feet B.M.}$$

The computations for this new rule can be made mentally, but paper and pencil may be more convenient. For all diameters ending in 1, subtracting 1 from D leaves a number ending in zero, which is easily squared. Likewise any diameter ending in 6 is reduced to a number ending in 5; to square it, square the 5 and multiply the preceding digit by one more than itself. Thus, to square 35, square the 5, obtaining 25; multiply the 3 by one more than itself, or 4, obtaining 12; the square of 35 is 1,225. The squares of other numbers can be obtained mentally, though not quite so easily, by the familiar binomial theorem method.

The average deviation of this rule from the International Rule ¼-inch kerf is 0.6 per cent for 16-foot logs ranging from 6 to 36 inches in diameter. For other lengths the deviation is larger, averaging 3 per cent high for 12-foot logs, 5 per cent high for 8-foot logs, and 3 per cent low for 20-foot logs. In other words, while the rule is excellent for 16-foot logs it is high for shorter logs and low fo longer logs.

The deviations for lengths other than 16 feet are to be expected, as comparison is being made with a rule which has a different formula for each length that is a multiple of 4. Should it be desirable to use more than one log rule, as suggested in these pages by Stevens and Bec ton, the better use for the additional rules might be for lengths other than 16 feet. The comparatively small deviations of th new rule from the International should not prove a great handicap to its use, as a large part of the scaling and most o the cruising in this country is performed on the basis of the 16-foot log as th unit. It is not intended that the new rul displace the International Rule in scaling practice. It is, however, an able substitute for the use of the forester whc finds himself without a tabulated log rule. While the values are not precisely th same as those of the International Rule they are close enough for most practica work. It should be remembered that th values of the International Rule are no exact, but are rounded off to the neares multiple of 5.

JOHN C. SAMMI,
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REPORT OF THE A.A.A.S. ATLANTIC CITY MEETING DEC. 28, 1936—JAN. 1, 1937

The usual complete program of the annual meetings of scientific societies included this year a most successful join afternoon session of the Society of American Foresters and the Ecological Society of America. The meeting was well attended and 31 members of the Society registered. The program was devoted to forest soil problems and evoked a lively discussion. Papers were read by H. A

Lunt, H. J. Lutz, R. F. Chandler, and T. S. Coile. A report on the comprehensive study of soils and hardwood growth by J. T. Auten was read in his absence by Dr. Robert B. Gordon, Ohio State University. Dr. C. F. Korstian presided in the absence of Dr. W. S. Cooper. The success of this meeting is most encouraging and suggests the desirability of holding independent meetings of the Society in connection with the A. A. A. S. when the annual meeting of the Society takes place at a point far distant from the A. A. A. S. meeting, as is the case this year.

Numerous other sessions approached the character of forestry meetings by the predominance of forestry papers on the programs. One session of the American Phytopathological Society was devoted entirely to tree diseases. A large number of entomological papers were similarly of forestry interest. All programs of the Ecological Society had a strongly forestry flavor, more than half of the papers being on forestry subjects or presented by foresters. In all, 21 members of the Society read papers, as far as could be learned. Two motion pictures, "Fire Weather" and "Flood Weather", were shown in connection with meetings of the American Meteorological Society. Over 60 papers on forestry subjects or related to tree physiology, protection, or soils were listed.

All meetings of the Council of the A. A. A. S. were attended by Dr. C. F. Korstian and Dr. Henry I. Baldwin, representatives of the Society. It should be noted that the Society now has two representatives on the Council by virtue of having over 100 members who have been elected Fellows of the American Association. A large part of the time of the Council was occupied with routine matters, such as election of officers and approval of reports of the Secretary and Treasurer. Announcement was made of a gift of $2,000 to be used for grants in aid of research. About one-half of the grants-in-aid are made through the state academies of science. There are now 29 academies eligible to receive such grants. The renewed danger to freedom of speech from teachers' oath laws was discussed and a standing committee was appointed to gather facts on the situation. Dr. G. D. Birkhoff was elected President for 1937.

The representatives of the Society also attended meetings of the Union of Biological Societies, where it was reported that *Biological Abstracts* must soon cease unless new financial support can be obtained. At the business meeting of the Ecological Society of America it was voted to accept the application of the newly organized wildlife specialists to affiliate. The Society was also unofficially represented by H. I. Baldwin at a meeting of the National Research Council Committee on Preservation of Natural Conditions.

The sustained interest in forestry subjects shown at these meetings each year furnishes justification for the contacts maintained by the Society with the A. A. A. S. during these years when the annual meeting of the Society is held at a different time and place. The field of forestry is so broad and the ramifications are becoming so increasingly great that there is scarcely an organization meeting with the American Association whose program does not touch on forestry. It is to the distinct advantage of the forestry profession to maintain close contact with these other professional groups, and one way to do so would be each year to hold a joint session with one of them which

has repeatedly included forestry papers in its program. Finally, hope is expressed that the annual meeting of the Society may soon again be held with the Association. Next year the Association's winter meeting will be held in Indianapolis. A join program for the Denver meeting is already being worked out by Society members in Denver.

H. I. Baldwin,
Hillsboro, N. H.

Will C. Barnes

1858—1936

Will C. Barnes, long in charge of the Branch of Grazing in the U. S. Forest Service prior to his retirement in 1929, died suddenly at his home in Phoenix, Ariz., December 18, 1936.

Barnes was born in California June 21, 1858, and grew up in Minnesota and Indiana, obtaining a public school education supplemented by special work in music. From 1879 to 1882 he served as private and sergeant in the Signal Corps, U. S. Army, and for extraordinary bravery in action with hostile Apache Indians (he was accredited with saving the garrison at Fort Apache) he was awarded the Congressional Medal of Honor. Engaging in the livestock business in Arizona and later in New Mexico, he served in the legislatures of both Territories and was for three years chairman of the Arizona Live Stock Board.

Acquaintance and association with Albert F. Potter, who had become Pinchot's chief adviser in connection with the range problems related to National Forest administration, drew him into the Forest Service in 1907, as Inspector of Grazing. Next to Potter's his was the leading part in developing Forest Service range administration. From 1915 to 1928 he was Assistant Forester in charge of grazing. In 1928 he became Secretary of the U. S. Geographic Board, a position in which he continued until 1930; he resigned to devote the rest of his life to writing, travel, and the varied interests which his active temperament and richly diversified gifts made him both ready and eager to be occupied with.

"When you hear that I am dead, do not shed any tears. I have had the best life a man ever lived, and am way ahead of the game right now." Fortunate indeed is the man who can make such a statement in all sincerity, as did Barnes during his later years. It expresses his philosophy, and appreciation of the worth-whileness of many-sided activity.

The esteem in which he was held by the thousands of people who knew him was evidenced in the tributes which his death called forth. Characteristic of the man was the satisfaction he had often expressed in knowing before he passed away what people thought of him. A book of letters from his many friends in the Forest Service, presented him when he reached the retirement age, was one of his most valued possessions. As he often remarked, the letters in that book were from the heart. How he was esteemed a few passages exemplify:

"Barnes, probably more than any other one individual in our organization, brought to the Washington office the spirit of the West—its freedom, freshness, tolerance. This doubtless has been his greatest contribution to our organization, even more important that his intimate knowledge of range conditions or the livestock business and his wide acquaintance with stockmen.

"At all times and under all conditions he has had a cheerful smile for everyone, from the newest messenger to the most dignified member of the Cabinet. We have all personally been rather proud of

Mr. and Mrs. Will C. Barnes, whose versatility and charm have made them the most widely known and most popular representatives of the Forest Service in Washington. As the official Santa Claus, dispensing gifts from the Forest Service tree every Christmas with hearty good cheer, 'Will C', has been an almost indispensable institution."

"Members of the Forest Service will find it difficult to believe that Will C. Barnes has reached retirement age. We see in him the same active, virile, energetic and enthusiastic personality which we saw when he entered the Forest Service twenty-one years ago. Years have neither taken from his intellectual keenness nor lessened his zest in life, with its varied interests—interest in people, in doing things, in all that enriches living, as well as in the Service and the many public activities in which he has played such an important part."

"Toiyabe days! Me, a punk of 21 or 22, with the weight of the world on my feeble shoulders. Sleepless nights of worry. Wild men—wild horses—and still wilder women—town sites booming on far-flung mining claims—saloons springing up on other forest acres—a thousand and one dismaying problems. If ever angel appeared to mortal man, you played that role when you appeared on those limitless horizons of central Nevada!

"That visit of yours was one of the most helpful, inspiring, stimulating experiences of all my enduring days. Your keen balancing of relative values—the oil you poured so expertly on troubled waters—your fatherly advice—your good-humored criticisms and suggestions, full of encouragement and good will. Boy! That was good medicine! I shall always be grateful for it.

"Kindness, courage, generosity, poise, perception—these are admirable, inspiring attributes of the human spirit. Of your spirit, W. C. B!"

"Old Timer, Howdy!

"The rough trails of the old days have been smoothed out—many of our friends have crossed the Great Divide—the open friendly hand has replaced the clenched fist—and plus fours have taken the place of Angora chaps. But what memories those are to have and to hold—memories of days when every step of progress meant a fight.

"Ever shall we be mindful that it was you who led the first cavvy across the plains and mountains of the West, and helped build up that *esprit de corps* and public confidence which to-day is the heritage of every Forest Service officer.

"Occasionally, on some steeper slope or some wider range of life there appears an outstanding figure moving in bold relief against a graven background or silhouetted against a colorful sky. Such a rare being is Will C. Barnes, and such an impression of vital personality is made upon those with whom he is associated even casually."

Barnes' published work included a volume of western stories entitled "Tales from X-Bar Horse Camp"; "Western Grazing Grounds and Forest Ranges"; "The Story of the Range"; and very many magazine articles and fugitive writings. He was also co-author of "Cattle". His last outstanding work was "Arizona Place Names". His knowledge of music, art, and history was reflected in his conversations, whether around a camp fire, in a library, or in an office. He was fond of travel, and some of his most interesting articles are descriptive of the various countries he had visited during a trip around the world, and of the habits and life of their peoples.

With all his accomplishments he was still a simple man, intensely interested in human affairs and the personal problems of those with whom he came in contact. He was also a naturalist, interested in animals, birds, grasses, flowers, and trees.

Thus Barnes, far beyond what is given to most men, lived a full life. He always desired that when his time came, it would come quickly; and so it proved. He kept on his desk for years John G. Neihardt's poem, ending:

> "And grant that when I face the grisly Thing,
> "My song may trumpet down the gray Perhaps,
> "Let me be as a tune-swept fiddle-string
> "That feels the Master Melody—and snaps!"

C. E. Rachford,
U. S. Forest Service.

Ernest Winkler

1877-1936

Ernest Winkler, Assistant Regional Forester, Region 4, U. S. Forest Service, died at Ogden, Utah, on the last day of 1936. Although his more than thirty years' service as a Forest officer was wholly in Region 4, not only did he have an important part in shaping and guiding the range industry in his own Region, but his influence extended through all the western states. He was one of the best-informed range men in the West and the Forest Service. Having been schooled from a young man in the practical phases of the livestock industry, and having the ability progressively to apply scientific determinations to its betterment, he was a consistent and recognized leader in all conservation matters affecting it, and was most favorably known as such throughout the Intermountain territory.

Both the popular characterizations of him and those of his associates in the Forest Service stress his strict honesty, consistent fairness, breadth of vision, industry, charitableness, and mature and dependable judgments. Whether acting as a public officer or in personal relationships, and whether he could grant or must deny requests, he never made an enemy. Flavoring his decisions, many of them difficult, with human kindness and friendliness, he exemplified in his work a high character of public service, rendered in the spirit of the West, and thus guided the course of western conservation along paths that led progressively to higher and larger achievements.

The Chief of the Forest Service said of him: "Ernest Winkler's wholesome personal influence, his square dealing, and his most valuable contributions to the course of national conservation measure larger than most men have recorded. He helped during the pioneer period of range administration, when his inherent character of service and leadership was a major need. Those contributions and many others during a long period of faithful service will not be forgotten. Along with the recognition of these things by his associates there has been a deep affection for him."

There have been many resolutions and expressions of personal loss from groups of stockmen with whom he conducted National Forest business, and from his contemporaries in various branches of the federal service. These have commended his high personal character and his service to the livestock, agricultural, and other interests. He was also an active participant in local activities, and a leader in a number of them—an honored and respected citizen and valued member of his community as well as a Forest officer of the finest type.

John H. Hatton,
U. S. Forest Service.

Action by the Intermountain Section

The Intermountain Section of the Society of American Foresters adopted, January 5, 1937, the following resolution:

Resolved: That the Intermountain Section of the Society of American Foresters at its meeting in Ogden, Utah, on January 5, with 50 in attendance, shall adopt by a rising vote followed by a brief interval of silence, the statement concerning the death of Ernest Winkler, and that this statement shall be transmitted to the Winkler family, and a copy to the Journal of Forestry for publication as an expression of sorrow over the loss of a beloved and highly respected Senior Member.

The statement accompanying the resolution reads in part:

Ernest Winkler in his early manhood handled livestock on the ranges of Utah and Nevada and studied at Brigham Young University and the Utah State Agricultural College, thus acquiring through practical experience and technical training an intimate knowledge of western range problems. In 1905 he entered the Forest Service as a Forest Guard and in successive stages advanced through the ranks to become Chief of Wildlife and Range Management in the Intermountain Region, a position he held from 1923 to the time of his death.

As Assistant Regional Forester, Ernest Winkler played an important part in shaping the destiny of the range livestock industry in the West. He trained or guided the development of many outstanding range technicians. He championed the interests of both large and small livestock producers and because of his practical and technical knowledge of the range and game resource, his fairness, and his willingness to serve, he was sought for counsel and his word invariably was accepted wherever range men gathered to formulated policies of wild life management. The sound and conservative policies which he fostered and vigorously supported undoubtedly will endure as a worthy contribution to the development of the West and as an enviable life's work for all forest and range men to follow.

Charles R. Meek

1889—1936

Charles R. Meek, for twenty-three years a member of the Pennsylvania Department of Forests and Waters, died in Harrisburg, December 20, 1936.

Meek entered the state Forest Service immediately upon graduation from the State Forest Academy at Mont Alto in 1912, and served with distinction in various State Forests. When the United States entered the World War he enlisted in the 10th (Forest) Engineers. Shortly after his return he was made Assistant State Forest Fire Warden of Pennsylvania. In 1928 he was appointed Chief of the Bureau of Forest Extension, in which position he supervised the four state forest nurseries and the Department's reforestation activities.

A Senior member of the Society of American Foresters since 1921, Meek had long been active in the affairs of the Allegheny Section. His official work and his warmth of personality had made him widely known throughout Pennsylvania, so that he was recognized as one of the outstanding men in the state Forest Service.

The following appraisal of his character comes from George H. Wirt, Chief Forest Fire Warden of Pennsylvania.

"In his work he knew nothing of saving himself. He was a servant of the people of Pennsylvania. As a forester he was anxious to learn whenever and wherever he could, and to use his knowl-

edge and experience to the advantage of the profession of which he was proud. As a co-worker in the Department he was jealous of its reputation, and did much to establish satisfactory relationships between the Department and the public all over the state. And to those with whom he worked he was loyal even to his own disadvantage.

"The many kind deeds he did will never be known for he was constantly on the alert to help someone who needed encouragement or material aid. He never failed to see the humorous side of even serious occasions, and his joy of life was contagious."

HENRY CLEPPER,
U. S. Forest Service.

REVIEWS

The Tympanis Canker of Red Pine. By John Raymond Hansbrough. *Yale University School of Forestry Bull. 43. 58 pp., 12 pls. 1936. Price $1.*

During the past thirty years the interest of foresters in diseases of forest trees has gradually increased, but even today forest pathology does not have the broad support its importance appears to justify. To be sure, extensive control programs have been developed and large sums of money have been expended to study and control, or attempt to control, certain highly destructive and spectacular tree diseases, such as white pine blister rust and chestnut blight. By and large, however, comparatively little attention has been given, and little support has been accorded, the study of the ordinary "woods-run" of forest tree diseases.

A few of the causes for this unsatisfactory condition are not obscure. In the first place, the pathological training of many of the older foresters has been deficient, and such individuals often are inclined to be somewhat skeptical of the importance of activities concerning which they know little. In the second place, pathological studies have often overemphasized scientifically interesting, but from a practical point of view comparatively unimportant, questions of fungus morphology, taxonomy, cytology, etc., and therefore have failed to stimulate much interest in the subject among those who should be most interested—foresters.

Lately an increasingly larger number of forest pathological problems have been studied by men having a common interest in both forests and fungi. Naturally, such men approach their problem from a somewhat different point of view. An attempt is made to learn everything possible about the parasite, not as the ultimate objective of the study, but rather to enable the investigator to ascertain its economic and silvicultural importance. "The Tympanis Canker of Red Pine" is a fine example of a study of this type.

According to common usage both in Europe and America, the fungus causing the Tympanis canker of red pine has been referable to the species *Timpanus pinastri* Tul., but considerable doubt exists whether Tulasne's name, *T. pinastri*, can be applied to this canker. The disease occurs on both red pine and eastern white pine, but is significant only on the former.

So far, the disease has been found only where the tree has been planted south of its optimum range, and it is of serious consequence only on plantation-grown red pine. The indications are that it is more severe in pure plantations than in mixed; that it may occur on all sites, but is generally worse on poor than on good sites; that in any stand it is more prevalent on trees of the lower than of the upper crown classes; that there is little if any relation between its incidence and the aspect, slope, and soil reaction; that in southern Connecticut

there is a remarkable relation between its appearance as an epidemic in 1930 and the serious moisture deficiency of that year; and that infection is inversely related to vigor as expressed in height and diameter growth of paired trees. The conclusion is reached that *Tympanis* sp. is a weak parasite of red pine and can cause disease only when the host is weakened by some environmental factor or complex of factors.

The canker is almost entirely annual. In this respect it is similar to the cankers of Douglas fir caused by *Phomopsis pseudotsugae* Wilson and by *P. lokoyae* Hahn. Individual trees may be killed outright when the main stem is girdled, or they may remain alive almost indefinitely but with permanent disfigurement of the bole. The damage to stands probably will not exceed 10 per cent of the expectation value of the crop.

Several methods of control are considered, namely: mixed planting with white pine, an eight foot spacing, and judiciously timed pruning and thinning. As the fungus is a common saprophyte on red and eastern white pine, no eradication or sanitary measures are recommended.

Many foresters probably will wonder why Hansbrough does not use Sudworth's common names for *Pinus resinosa* and *Pinus strobus*. To be sure, the author states why he prefers the name red pine and eastern white pine. The soundness of such preferences, however, is open to question. If one wished to apply the same reasons to the common names of the other 1,175 trees included in the "Check List", a large number of them could be changed. It is the opinion of the reviewer that strict adherence to "Check List" terminology is by far the better practice to follow.

HENRY SCHMITZ,
University of Minnesota.

Fire Control Notes. A Publication Devoted to the Technique of Forest Fire Control. *52 pp. Forest Service, U. S. Dept. of Agriculture. Washington, D. C. December, 1936.*

For a number of years foresters in research and administrative protection work have felt the need for a continuing publication devoted to the increasingly specialized technique of fire control. This is the first of a proposed series of such publications. In composition and arrangement it promises adequately to fill the need.

Compiled by the Division of Fire Control, the present issue contains 24 brief and informative articles on a variety of subjects. The reason for establishing the publication is stated by Roy Headley, Chief of the Division:" 'Fire Control Notes' will seek to act as a channel through which useful or suggestive information may flow to each man in his field, whether he be a fire-research worker attacking some fundamental of combustion, or a fire fighter, facing the flame and smoke, who discovers some new device for organizing a crew of laborers."

Contributions are invited. Articles and notes, whether four lines or ten pages in length, are wanted on any phase of fire research or fire control management: "theory, relationships, prevention, equipment, detection, communication, transportation, cooperation, detection, communication, transportation, cooperation, planning, organization, personnel management, training, fire-fighting methods or reporting, and statistical systems."

Space is not available to list all the articles in the first issue. Among them are items on aerial and chemical aids in extinction, fire-behavior studies, radio, the use of mil scale binoculars, a

new principle in fire-line plow construction, extra-period fires, and others of considerable interest to the forest protectionist.

"Fire Control Notes" will be published intermittently as contributions accumulate. Distribution is not limited to members of the Forest Service, but includes individuals and organizations who cooperate with it in stopping forest fire waste. The second number has been announced for early publication.

HENRY E. CLEPPER,
U. S. Forest Service.

Roadsides—The Front Yard of the Nation. By J. M. Bennett. *vii + 233 pp. Illus. The Stratford Company, Boston, Mass. 1936. Price $3.*

Secondary only to convenience and comfort in travel is the pleasure derived from what is seen along the way. A most gratifying feature of recent highway construction is the increased effort to furnish and maintain attractive roadsides, as well as smooth pavements. Mr. Bennett, Superintendent of Parks and Forestry in Wayne County, Mich., describes in detail the successful methods that have been developed during 18 years in which he has specialized in this branch of highway engineering. It is not a textbook or a manual of procedure, but a compilation of information covering all the present known ramifications of roadside development, something of its historic background, and its practical application.

The book is written in an interesting and nontechnical manner. All types of roadside landscaping and the methods of upkeep recommended tend to the practical and naturalistic rather than the overformal and expensive. There is a great deal of information about trees, shrubs, and ground cover, and advice regarding the retention of existing native material, planting, and after-care, of unusual value to managers or owners of country estates as well as to those more directly connected with highway management.

Perhaps the most interesting chapter to the forester is one giving a resumé of tree history dating from geologic eras, and a description of early customs in tree planting as well as those of the present day. Necessary public conveniences, overhead utility wiring, and "timely and untimely" road signs are discussed and illustrated by photographs. The book contains an extensive bibliography on this rather new subject of roadside landscaping and improvement.

GEORGE A. CROMIE,
New Haven, Conn.

The Study of the Soil in the Field. By G. R. Clarke. *142 pp. 7 figs. (Clarendon Press) Oxford University Press, New York. 1936. Price, $1.75.*

The aim of this little book is to help the beginner and the soil scientist to observe and record what is to be seen in the soil. It is essentially a guide for field study, mapping, and classification of soils, as indicated by the captions: "Soil-site characteristics, the soil-profile pit, soil-sample collection, mapping of soils, notes on soil-survey systems of Bavaria, Hungary, Russia, America, and England." Detailed and complete suggestions as to what to expect and forms for recording are included. Most of the items are familiar to those who have worked with soils, but many, such as structure, constitution, and proportion of mineral skeleton in the profile description contain suggestive material not so well known. The comparisons between

methods and systems in different countries clearly indicate the present lack of standardization, but at the same time they emphasize the fundamental value of the soil profile and its characteristics as a basis.

It is interesting to find the author, as Clements does with plant communities, comparing the soil to a living organism in contrast with "dead" soil samples as they are usually studied in the laboratory. In his words, "Vegetation and soil are completely merged into a natural living unit." Even if one does not find the analogy with an organism entirely helpful, it is valuable in emphasizing the importance of studying the soil in place, with its natural environment.

Foresters will be interested in the definition of site as "a unit of land suitable for a single system of utilization".

Strong emphasis on the vegetation as one of the characteristics of a soil site is justified because the author feels that vegetation and soil rapidly attain equilibrium in their respective development. He cites an example near Oxford where plantations of eight species of conifers and eight of broadleaved trees on a typical brown forest soil after 30 years have each developed a specific profile, at least for the A horizon. A question might be raised whether the soil changes always keep pace with the early and rapid changes in vegetational succession that are found in the United States. At least there is evidence that the soils, in some places, are not sufficiently differentiated after several stages of forest succession over a period of several hundred years to justify their classification in different soil types.

Natural vegetation is also suggested as a useful means of indicating boundaries between soils in mapping. This point of view may be compared with that of Marbut who contended that soils should be differentiated and mapped on the basis of soil characteristics without regard to vegetation or other associated phenomena.

The book brings together in a usable way information not heretofore available that will be valuable for any forester who has occasion to make careful field study of the soil.

J. Kittredge, Jr.,
*University of California,
Division of Forestry.*

Massenberechnungstafeln für Holzvorratsaufnahmen (Computation Tables for Wood Volume Surveys). By Wilhelm Von Laer. *79 pp. Paul Parey, Berlin. 1936. Price (in U. S. A.) Rm. 4.35.*

Three sets of tables, derived from the Grundner-Schwappach volume tables, are presented in an effort to simplify the work of computing volume of stands from timber survey tallies, and coincidentally, to minimize the common error of not listing the correct number of significant figures in the resulting totals.

The author points out that the volume of the trees in any d.b.h. class is the product of four factors, viz., basal area, height, form factor, and number of stems. These are of very different magnitudes; basal area (in square meters) and form factor are less than 1, but height and number of stems are invariably greater than 1. Consequently the calculation of volume involves decimals which are later discarded in rounding off the product to whole meters.

The first set of tables presents form-height products (in tenths) and is entered with d.b.h. (in 4 cm. classes) and height (in meter classes). There is a separate pair of tables for each commercial species; one of each pair contains form-height less 10 per cent to allow for loss in felling.

The second set of tables contains multiple basal areas (in tenth sq. m.) and is entered with d.b.h. (in 4 cm. classes) and number of stems. Volume of a d.b.h. class, then, is the product of corresponding entries in the first and second sets of tables. Even this calculation need not be performed, for the third set of tables presents volume (in cu. m.) corresponding to form-height (in tenths) and total basal area of the d.b.h. class (in tenth sq. m.).

The booklet also contains a short history of the German volume tables as well as a bibliography of 15 references for those interested in more detailed history.

F. X. SCHUMACHER,
U. S. Forest Service.

La "moria dell' olmo" (Graphium ulmi). By Gabriele Goidanich. *136 pp., 44 figs. Ramo Editoriale degli Agricoltori. Rome. 1936. Price 8 lire.*

La Grafiosis del Olm oy la Demonstracion de su Existencia en Espana. By José Benito Martinez. *Instituto Forestal de Investigaciones y Experiencias. Año 9, no. 15. pp. 7-29. 7 pl. 1936.*

Goidanich, a member of the Royal Station of Plant Pathology of Rome, discusses the occurrence and behavior of the Dutch elm disease in Italy. Based on his own researches and on data from other Italian and from foreign sources, he discusses the elm species, their properties and utilization; the origin, characteristics and methods of distribution of the disease; the parasite causing it; its morphology, physiology, and cultural and biologic behavior; and the means of combating it under Italian conditions.

He believes that the disease is of more serious economic importance in Italy than in any other country. Not only is elm a valuable forest and ornamental tree, but it is used extensively as a live support for vines. The trees are planted in rows along the borders of the fields, and on them are strung the wires which carry the vines. Dead stakes and concrete posts are not satisfactory vine supports in Italy, and other species of trees are not as suitable. Elms also furnish foliage for feeding to animals, and the twigs are used for staking plants or for fuel.

Three kinds of elm are endemic in Italy: *Ulmus foliacea* (syn. *U. campestris*), *U. glabra* (syn. *U. montana*) and *U. laevis.* The first is the most abundant. All are susceptible to the disease. The elm disease is reported in ten of the fourteen provinces of the Italian mainland. It is serious in two of them; Emilia in the north central part, and Campania in the southern part of the country. In one locality in Emilia 90 per cent of the elms are reported dead; in five other localities from 52 to 78 per cent are dead; and in nine more 33 to 45 per cent. All this loss has occurred in a short time, as *Graphium* is not believed to have been present in Italy more than six or seven years. The disease may be acute and kill the tree rapidly, or it may be chronic and operate over a period of years.

In seasonal periodicity of development the disease in Italy is intermediate between that in the United States and that in northern Europe. The first signs of wilting appear early in June and the greatest number of cases early in July.

The author urges that resistant elms be substituted for the susceptible ones now grown. He advocates the use of any resistant individuals of the European species which may be found or produced by breeding, but points particularly to the Siberian elm as highly resistant and

suitable for the purposes to which elm is put in Italy.

In regions where the disease is just entering or in zones around badly infected areas he advocates direct methods of combat, especially the debarking of cut trees and the burning of the bark.

Martinez summarizes information on the symptoms, causal organism, pathology and distribution of the Dutch elm disease, reports its first authenticated occurrence in Spain. It was found at Aranda de Duero in the province of Burgos, north of Madrid. Remedies suggested are the selection of resistant species and varieties of elms and the destruction of dead or diseased trees to slow down the movement of the disease.

R. KENT BEATTIE,
Forest Pathology,
Bureau of Plant Industry.

Erkennen, Nachweis und Kultur der holzverfärbenden und holzzersetzenden Pilze. (Recognition, demonstration and culture of wood-staining and wood-destroying fungi) By Werner Bavendamm. *Handbuch der biologischen Arbeitsmethoden, Lieferung 457 (Abt. 12 Teil 2, Heft 7.) Pp. 927-1134. Fig. 95-141. Urban & Schwarzenberg, Berlin and Vienna. 1936. Price Rm. 11.50.*

This is the most exhaustive account of decay in living trees and wood in service that has yet appeared. The discussion of staining is brief. The paper is an indispensable handbook for investigators in the field of wood decay, including as it does an extensive bibliography closely correlated with the text, thus enabling a reader to obtain readily the important titles on any specific subject. Furthermore the paper is valuable historically, for the development of research on various topics is considered from the beginning. In addition to the macroscopic, microscopic, and chemical aspects of decay, over half the pages treat of the development of wood-inhabiting fungi in pure culture, which has become an essential method for identification of fungi causing decay or stain when no fructifications are present. The relatively few species of economically important wood-destroying fungi in Europe makes the diagnosis of decay there a simpler problem than it is in America.

J. S. BOYCE,
Yale University.

Through the Woods: The English Woodland—April to April. By H. E. Bates. *142 pp., with 73 wood engravings by Agnes Miller Parker. The MacMillan Co., New York. 1936. Price $3.*

Here is a delightful book for nature lovers, beautifully written and illustrated. The artist's name, indeed, is given equal weight with that of the author; her distinguished wood engravings depicting trees, their buds and flowers, birds, and other forest wildlife add greatly to the attractiveness of a well designed volume.

In describing the Kentish woods in all seasons the author's approach is sentimental rather than scientific, but his observation of the minutest details of the forest community might be of interest to foresters who are students of phenology and ecology. Still, it is to lovers of the woods for their beauty as a part of nature that this book makes the greatest appeal—and foresters are naturally woods lovers, else why did they choose to be foresters?

The book is rich in imagination and not without humor, even irony. The

author's tenderness for nature's creatures does not extend to the majority of the human race.

JULIA H. DROWN,
U. S. Forest Service.

Game Management on the Farm. By J. N. Darling, H. P. Sheldon, and Ira N. Gabrielson. *U. S. Dept. of Agric. Farmers' Bull. 1759. 22 pp. Illus.. 1936.*

Groups of Plants Valuable for Wildlife Utilization and Erosion Control. By W. L. McAtee. *U. S. Dept. Agric. Circ. 412. 12 pp. Illus. 1936.*

In its own way, each of these recent contributions from the Biological Survey fills a long-felt need.

"Game Management on the Farm" explains in simple language how the farmer, or for that matter any rural landowner, by the practice of a few easily understood rules of game management, can amend conditions of ground cover so that small game animals, particularly birds, will be attracted to and multiply on his property. From a practical standpoint the worth of the publication lies in its demonstration of how game management can be made to fit the land.

Too often, suggestions for farm improvement and practice, by insisting on the expenditure of time and funds beyond the means of the average farmer, antagonize the recipient instead of convincing him. This bulletin avoids that error. It points out that game management is not a complicated process, and shows how ditches, eroding hillsides, rough land, and brush patches may be utilized to produce game food and cover with profit to the farm owner.

McAtee's circular, though it is more likely to appeal to the technician than to the landowner, explains how plants valuable for wildlife may be utilized in the establishment and maintenance of vegetative cover for erosion control. He shows that for optimum game production cover is quite as indispensable as food. "Man", he writes, "may appraise cover requirements to the best of his ability and plan and modify cover according to this appraisal, but the final test of value is the degree of use, and sometimes this appears to depend upon something that the particular form of wildlife concerned recognizes but man does not."

Plants known to be of most value in providing cover, browse, herbage, mast, fruit, and seeds for wildlife use are listed in systematic order. Available native species of the genera listed may be transplanted or may be obtained from nurseries. Barberries, currants, and buckthorns are omitted because they harbor rusts. Poisonous plants also are excluded.

The author lists 150 species of crop and pasture plants, vines, trees, and shrubs, for use in erosion control.

All foresters, especially those in soil conservation and extension activities, should find these two publications timely and useful.

HENRY E. CLEPPER,
U. S. Forest Service.

The Story of News Print Paper. *76 pp. Illus. Published by the News Print Service Bureau, 342 Madison Ave., New York. 1936.*

This attractive booklet was "prepared especially for the purpose of supplying authoritative information upon the manufacture of newsprint paper for the use of newspaper publishers, librarians, students in journalism, forestry, and eco-

nomics, school teachers, and others". It is written in simple, nontechnical language and illustrated with excellent full-page photographs of the various stages in paper manufacture. A large portion of the book consists of reprints of a series of informative advertisements that appeared in *Editor and Publisher* in 1936. Curiously, although it is stated that North American newsprint manufacturers own or control nearly 100 million acres of timberland, there are only two short sentences in the whole book that even hint at any connection between the industry and forest management for growing future pulpwood supplies.

Although the story is told along very broad lines and does not give sufficient details for a very thorough understanding of the problems of the industry, it should serve its purpose of arousing interest in some of them.

W. N. SPARHAWK.

The Principal Rots of English Oak. By K. St. G. Cartwright and W. P. K. Findlay. *V + 38 pp., 2 figs., 13 pl. Department of Scientific and Industrial Research. H. M. Stationery Office. London, 1936. Price 2 Shillings.*

Besides rots in standing trees, felled timber, and buildings, this booklet briefly discusses stains and discolorations of oak wood. For each principal rot the gross and microscopic characters of the affected wood are described, together with a description of the sporophore and of the behavior of the causal fungus in culture. Economic importance is also considered.

Most of the rots of English oak also occur on oaks in the United States. Of particular interest is "brown oak", a decay of the heartwood of living trees caused by the beefsteak fungus (*Fistulina hepatica*). The decay develops slowly, at first appearing as discolored streaks, but gradually the entire heartwood acquires a rich brown color while remaining hard and firm. "Brown oak" commands a higher price than normal wood; this is the only instance known to the reviewer of decayed wood being more valuable than sound. Recently oaks in the eastern United States have been found with this brown wood.

According to a prefatory note it is planned that this shall be the first of a series of papers on the wood-destroying fungi of the important timber species of Great Britain. We hope that others will appear soon and maintain the excellent standard set by this one.

J. S. BOYCE,
Yale University.

CORRESPONDENCE

Editor, JOURNAL:

I have read the editorial "A Divided House" in the December number of the JOURNAL with great interest. It calls attention clearly, and with impartiality and restraint, to a condition which has plagued conservation and hampered desirable projects for a good many years.

I feel especially strongly on the matter because, as one of the two representatives of the general public on President Coolidge's Committee of the National Conference on Outdoor Recreation to make field investigations of boundary disputes between the National Parks and National Forests, I had an unusual opportunity to see the different points of view at close range. Congressman Henry W. Temple was Chairman, and the official representatives were Mr. Mather for National Park Service and Colonel Greeley for the Forest Service. We agreed unanimously about the extension of the Yellowstone to include the Grand Tetons, and the Grand Canyon to take in the southern part of the Kaibab National Forest; both of these projects have been enacted, with minor modifications. But we split on the addition of the Minaret Area to the Yosemite, and of Diamond Lake to the Crater Lake. We found, and this is a point which I should like to add to those covered in the editorial, that there may be entire agreement on the basic priciples distinguishing a National Park from a National Forest, but when it comes to applying these principles to a given area differences of opinion may arise, and often do if the area is not of such outstanding national importance scenically as to overwhelmingly counterbalance the needs of the local communities for its resources, or if the resources involved are very large. That seems to be the root of the difficulty over the Mount Olympus project.

Would it not help to bring the divided house together if there were some project on which both sides could agree, and if both sides could be stirred up to work together in support of that project? It occurs to me that the Quetico-Superior is just such a project. The proposal is to take in the well known lake region in northern Minnesota, said to be some of the finest canoe country in the United States still unspoiled, and a large area opposite, in Canada. The plan provides for three zones, the outer of which would be for hotels, stores, etc., the second would have summer cottages and camp sites, and the inner one would be kept as a wilderness. The forest would be utilized throughout the entire area, even in the wilderness, except for strips along the margins of the lakes and canoe routes. This seems to me thoroughly sound conservation, the kind that both park and forest groups can support. In fact it was through the united support of both groups that a very determined effort by the powerful Backus interests to build dams for water power, which would have raised the lake levels and flooded the streams, was finally defeated in Congress in 1931 in one of the hardest fights ever seen on Capitol Hill. Since that time the project has been kept alive by the efforts of Ernest C. Oberholtzer, the Executive Secretary of the Quetico-Superior Committee, and a few supporters, but the progress has been small. The opportunity for united action by conservation forces is available, and, if grasped, can, I feel sure, do a great deal to heal the division which, as the editorial points out, is

doing so much to hamper sound conservation progress.

BARRINGTON MOORE,
Corfe, Taunton, England.

DEAR PROFESSOR CHAPMAN:

Your article entitled "Effect of Fire in Preparation of Seedbed for Longleaf Pine Seedlings" in the September issue of the JOURNAL OF FORESTRY makes a strong case in regard to the early requirements of longleaf pine. Evidently it is essential that seeds reach the mineral soil, that the young seedlings be free of overhead shade, and that they be reasonably free from root competition. The beneficial effect of grazing in reducing grass competition seems to me very conclusive. It is fortunate that the seedlings are not browsed after the first year. It also seems to me that with the rapid growth you get in the South, adequate stocking of pine will soon result in excluding grazing.

Whenever I read an article like yours I find myself comparing conclusions with those reached in my ponderosa pine studies in the Southwest. Doubtless you recall my article entitled "Grass, Pine Seedlings, and Grazing" in the May 1934 issue of the JOURNAL. Briefly, the conclusion is that complete removal of grass results in the best establishment of pine seedlings. Only a few become established in undisturbed bunch grass, and relatively few where the grass is clipped. The conclusion in this controlled experiment confirms earlier observations in my study of the 1919 seedling crop. Relatively light grazing of bunch grass in the last 8 or 10 years has resulted in a cover that is bound to prove detrimental to further establishment of pine seedlings. Furthermore, fires of 100 acres or more in bunch grass and old slash are occurring with alarming frequency. In my judgment we are going to have to resort to periodic heavy grazing, restricted during the periods when seedlings are most susceptible to browsing. It is becoming increasingly evident that range management designed primarily to improve the range does not meet the requirements for forest reproduction on areas of luxuriant herbaceous cover. It is also becoming evident that, wherever grazing is so regulated as to permit good pine reproduction, the pine will eventually take practically complete possession.

The editorial "Range Conservation and the Public Land Laws" in the November issue of the JOURNAL presents some interesting sidelights on the political aspects of the range problem. Granting that unsound governmental policies, wrong methods of grazing, and a wrong attitude on the part of the stockmen are directly responsible for the present condition of the range, a more fundamental factor is the submarginal character of the range itself. "The Western Range" recognizes submarginality in privately owned lands, but assumes that transferring ownership to public agencies takes these lands out of the submarginal class. This is true only in so far as investment in the land is concerned. Truly submarginal range lands are those whose potential grazing capacity is too low to justify the investment in water development and other improvements required for effective utilization and perpetuation of the forage crop. A look at the map and an estimate of the areas which receive materially less than 15 inches annual precipitation may well raise doubts as to whether economic range use will ever become possible on much more than half of what is now classed as western range. Government ownership of both land and improvements, together with low grazing fees, would in most instances solve the problem as far as the stockman is concerned.

Conservationists generally will agree that public agencies should acquire submarginal range lands, but there are some who may object to spending additional public funds merely in order to have these lands grazed. Experience in the Southwest has shown that expensive range

management is no insurance against deterioration of submarginal lands. The only range improvements justifiable on such lands are fences designed to keep domestic livestock out. Range management can not make cattle thrive without feed, nor can range research make grass grow without rain. To encourage a range industry on submarginal range lands by federal aid is just as illogical as it would be to attempt by similar means to perpetuate and extend "dry" farming in the dust bowl.

G. A. PEARSON,
Tucson, Ariz.

Editor, JOURNAL:

In the JOURNAL for June, on page 641, Minckler offers interesting comments on my article on forests and water in the April number. I agree with him most heartily on the need for quantitative data on forest transpiration to put that subject on a scientific basis. It is gratifying to know that he is working to that end. It was the lack of such data or of any likelihood of their becoming available in the near future that led me to venture to use assumed figures to illustrate possible changes in transpiration, evaporation, and interception losses of water as they might be related to changes in the age and density of the forest.

Minckler points out "errors" in two of my assumptions; first, that a 40-year forest will use 12 inches of water annually, and second, that a reduction of crown density from 0.8 to 0.4 would result in a decrease of transpiration by one-half. With his second criticism, that the decrease would be less than one-half, I am inclined to agree, although I would hesitate to use comparisons of transpiration of seedlings in full sunlight and in shade, or of peripheral and interior branches, or of any other figures at present available, as an adequate indication of the exact magnitude of the change.

In support of his first question, whether a 40-year forest will use 12 inches of water annually in a region of 22 inches of annual precipitation, Minckler cites his determination of 4 to 5 inches annual transpiration in a 50- to 60-year beech-maple forest in a locality of over 45 inches annual precipitation. The accuracy of his figure may for the moment be admitted, although several interesting applications of sampling are involved in proceeding from 6 minute determinations on single branches to total annual water use by all the trees on an average acre. In suggesting the application of his results from a region of 45 inches of precipitation to one of 22 inches, however, he is perpetuating one of the unscientific practices which has tended to discredit some of the earlier writings on forest influences, namely, the assumption that figures from one forest region and climate are applicable in a different forest region and climate. Twenty-two inches annual precipitation is associated only with the drier portions of the forests of the western United States, where the relative humidity is low, the evaporating power of the air high, and the growing season long as compared with the Adirondack forest. In so far as these are factors in transpiration, its magnitude should be greater in southern California than the 4 or 5 inches in the Adirondacks.

The evidence summarized by C. A. Taylor (Trans. Am. Geophysical Union, Pt. II, 554-9, 1934) is reasonably conclusive that annual water losses from areas of native vegetation in southern California range from 12 to 78 inches, and usually account for all of a seasonal rainfall of less than 19 inches. The higher figures apply only to areas of canyon bottoms with perennially high water table, which occupy about 3 per cent of total watershed area. This 19 inches, then, corresponds to the 20 inches which I used for my 40-year stand for the sum of interception, transpiration, and evaporation. Six inches interception, or

27 per cent of the 22 inches precipitation, is supported by data from various sources. Two inches runoff accords with streamflow records. There remains the 14 inches to be apportioned between transpiration and evaporation. In a dense 40-year forest, the ground would be heavily shaded and the forest floor well developed. The rains are concentrated in the winter season, when atmospheric conditions are unfavorable for evaporation. Seasonal evaporation from bare exposed soil in the same region has been found to be about 4 inches. (Calif. Div. of Water Resources, Bull. No. 33, 1930.) Two inches from the forest-covered soil seems not unreasonable. We then have left for transpiration the 12 inches, which I assumed. Although not based on direct experimental evidence, I cannot agree with Minckler that it is a "serious error".

JOSEPH KITTREDGE, JR.,
University of California.

Both the preceding letter from Mr. Kittredge and the following one from Mr. Mollenhauer are published with editorial apology for their greatly delayed appearance. Mr. Kittredge's letter bore date of July 15, but was regrettably lost sight of after its receipt. Mr. Mollenhauer's was apparently lost in transmittal, and when a second copy was submitted it was too late to be included in the January JOURNAL, which necessitated holding it over for the present number. Fortunately, in both cases the lapse of time does not make the substance of either communication obsolete.

Editor, JOURNAL:

Since the JOURNAL is more or less professional and nonpartisan, I was somewhat amazed to read in the June issue an article that is not only outright propaganda for a subject that is false and repugnant alike to humanitarian and scientist, but violently contrary to all American ideals. I refer to "The C.C.C. in Germany", by Arthur Ringland.

The most charitable excuse for Mr. Ringland's assumptions and statements is that his preoccupation with direct silvicultural forestry has prevented him from following labor and social movements. The result is that he "believes" Bulgaria established the first of such "organized labor services", but does not know that Bulgaria and other semifascist nations merely transplanted to Europe the Corvee, or forced donation of labor service, practiced by imperialists in colonial countries for decades before the World War, but which could not be successfully introduced into Europe until Fascism had crushed the labor unions in the respective countries.

In his enthusiastic acceptance and quotation of Nazi propaganda he certainly fails to consider the implications of many of them. "The German experiment was so successful that the Service became virtually compulsory for both young men and women." Just why is compulsion necessary for something that "is popular, and is now accepted as a national institution"?

Mr. Ringland writes of the "powerful, conscious educational program aimed to indoctrinate these youths with the philosophy of national unity." Does he mean National Socialism when he writes of national unity, and if not, perhaps he can quote some authentic Nazi material in which these two are not identical?

It is most interesting to note that "physical or mental defectives or social delinquents are not permitted to enroll." I presume Jews and other nonNordics would be included in physical; and Catholic, Communist, Trade Union, Socialist, and all democratic left and liberal elements not agreeing with the Nazi overlords under social delinquents. Later on the author states "The career service is open to all", from which I wonder if he agrees with the Nazi madmen that Jews, socialists, and all democrats are not truly human and so cannot be included in "all"?

Mr. Ringland sees only tradition in what he thus describes: "The love of marching and singing is so much a part of German tradition that the work soldiers, for that is what they are called, never go to work without marching." Others not so enamoured of Hitler's plans for Mittel Europa see the brutal militarization of a peaceful people and a new trick for supplying free labor service to the Yunkers and industrialists, while further lowering what are already starvation wages and conditions.

There are many faults with our C.C.C., but when the author adversely compares an institution of this government with some tyrannical abortion of the Nazi despotism, he is offering an insult to American foresters and Amercian citizens; and when he advises, "Should a permanent organization (of the C.C.C.) be undertaken, we can well profit by adopting some of these principles of the German Labor Service", I wonder does he mean the principle of leadership-blind obedience to force, or the principle of racial purity and supremacy of the Nordic, whatever that is, or the principle of concentration camps and ley de fuga for dissidents, or the principle of the glory of war and death on the battlefield, and so on ad nauseam?

If the author intends the article as partisan propaganda, then this should be clearly indicated and he should be prepared to defend it as such, while the editors should arrange to have the other side represented. Unless this is clear, the masthead statement of nonresponsibility for signed articles may not be sufficient, as the Nazis are ever on the alert to collect such stuff for home consumption as proof of the high esteem in which their system is held abroad.

Often foresters confine themselves to the work of growing and harvesting nonagricultural crops, but we must consider the human side as well as the dollars and cents involved in our work. If we develop methods for producing naval stores and white oak staves at half the present cost and fail to make provision for raising the living standards of the workers engaged in their production, we are poor foresters and poorer Americans. If we develop the most efficient nonagricultural land utilization in the world, and acquiesce in the loss of the ideals and liberties for which men have fought for thousands of years, then better that this country had never known forestry; and when foresters can see anything but menace in a system which has degraded woman, fettered science and art, officially loosed the furies of race hatred, and made the glory of war a national lust, then it is time that all of us take stock of where we are headed, and act before it is too late.

If some of us still fail to see that Fascism is synonymous with war, oppression, and suppression of all liberty, then it would pay us to devote time and space to a discussion of whether we are ready and willing to trade the Declaration of Independence for Mein Kampf, and the Constiution of the United States for the Lictor's rods and ax.

William Mollenhauer, Jr.,
Huntingdon, Pa.

Editor, Journal:

The article entitled "The C.C.C. in Germany" was not prepared originally for publication, but as one of several papers on the labor services of England, Germany, France, Switzerland, Austria, and Australia, for the information of the Emergency Conservation Work officials of the Forest Service. In the article in point, particular care was taken to state in a footnote that the material was "based on extracts from 'The National Labor Service,' by Dr. Kurt Stamm, 'The Spirit of the Labor Service,' by Colonel Hierl, 'Objective and Meaning of the Labor Service,' by A. Krugen, and 'Education and Selection in the National Labor Service,' by Paul Seipp; Hamburg World Economic Archives; and observations of

Mrs. William Christian, American Council of Education, in Germany (1931), W. N. Sparhawk, U. S. Forest Service, in Germany (1935), and the writer in Bulgaria (1922) and Danzig Free State and Germany (1932)."

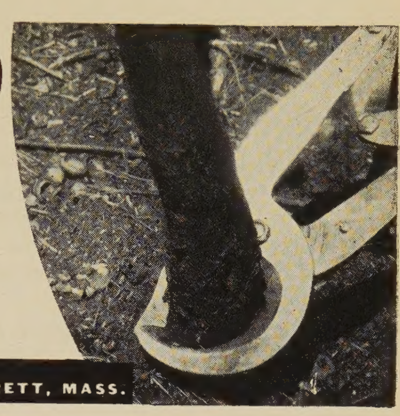
It was supposed that the reader would readily understand that the article was simply a task of editing factual material and bringing the information together. The only two paragraphs in the article that may be considered original are the introduction and the conclusion.

In the conclusion it was stated: "It will be seen that in many respects the German organization parallels our Civilian Conservation Corps. But there are a few notable exceptions. The German Service is permanent and virtually compulsory; work projects are undertaken only with public bodies, and on a cooperative and contributory basis preceded by expert appraisal and conditioned by contract, and following detailed working plans; the supervisory personnel is recruited from the ranks after completion of training in special schools; it is a career service for the personnel of all supervisory grades, and under civil service regulation. Public opinion in America generally supports the thought of a continuing C.C.C. Should a permanent organization "be undertaken, we can well profit by adopting *some* of these principles of the German Labor Service."

The purpose of the article was to emphasize (1) the character of the work projects, how they are evaluated, the cooperation demanded and the conditions of contracts; (2) the training schools for personnel; (3) the merit system and the civil service. All of these points were developed in detail in the article and are of particular interest to those of us who have taken a part in the development of the C.C.C. and look forward to its establishment as a permanent institution.

Mr. Mollenhauer's heated letter suggests that all knowledge of Germany, Italy, and Russia today is anathema "repugnant alike to humanitarian and scientist and violently contrary to all American ideals." There is a way out, Mr. Editor. Let the Society establish an *index librorum prohibitorum* for the 100 per cent Americans. But for those of us who are still striving to reach the Ivory soap standard of 99.44, please be liberal (where have I heard that word before?), and let us have a mere *index expurgatorius!*

ARTHUR C. RINGLAND,
Soil Conservation Service.



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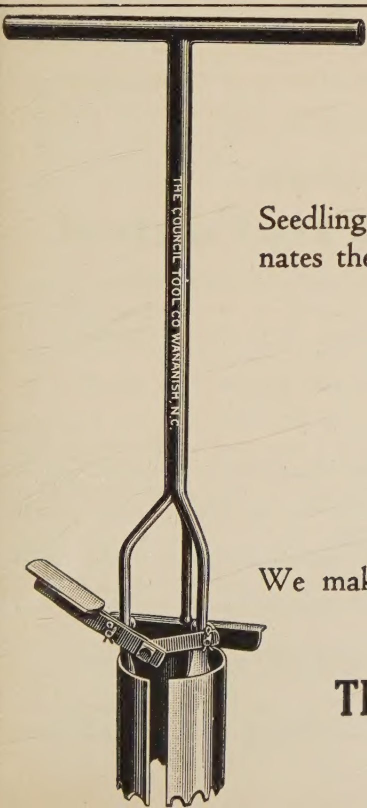

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